HUBER ENGINEERED WOODS

Overcoming Structural Floor Squeaks in Wood Framed Construction

Course # HEW 101
6/21 12:30, 4:00
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Speakers List

- **Ryan Stephenson**
  - **Mid Atlantic Business Development Manager**
- **Brian Shores**
  - **Midwest Business Development Manager**
- **Don Simon**

  Education and Training Manager

Learning Objectives

After completing this presentation, you will be able to:

1. **Identify and recognize the durability and safety characteristics of high performance wood framed floor systems with superior strength and stiffness attributes.**

2. **Investigate the multiple components of a wood framed floor system and the ways that they all contribute to improved performance and the elimination of movement and floor squeaks.**

3. **Assess the functional contributions of engineered wood subflooring as it relates to structural strength, fastener retention, water resistance, and overall stiffness.**

4. **Design and specify wood framed floor systems that perform as intended and reduce or eliminate squeaks that are indicators of other issues.**

Overview

Why are there so many squeaky wood floors?

- Longer floor spans
- Availability of skilled labor
- Lack of quality control
- Lower quality materials
- Combination of all of these things

Typically, floor squeaks are a sign of construction problems

Overview

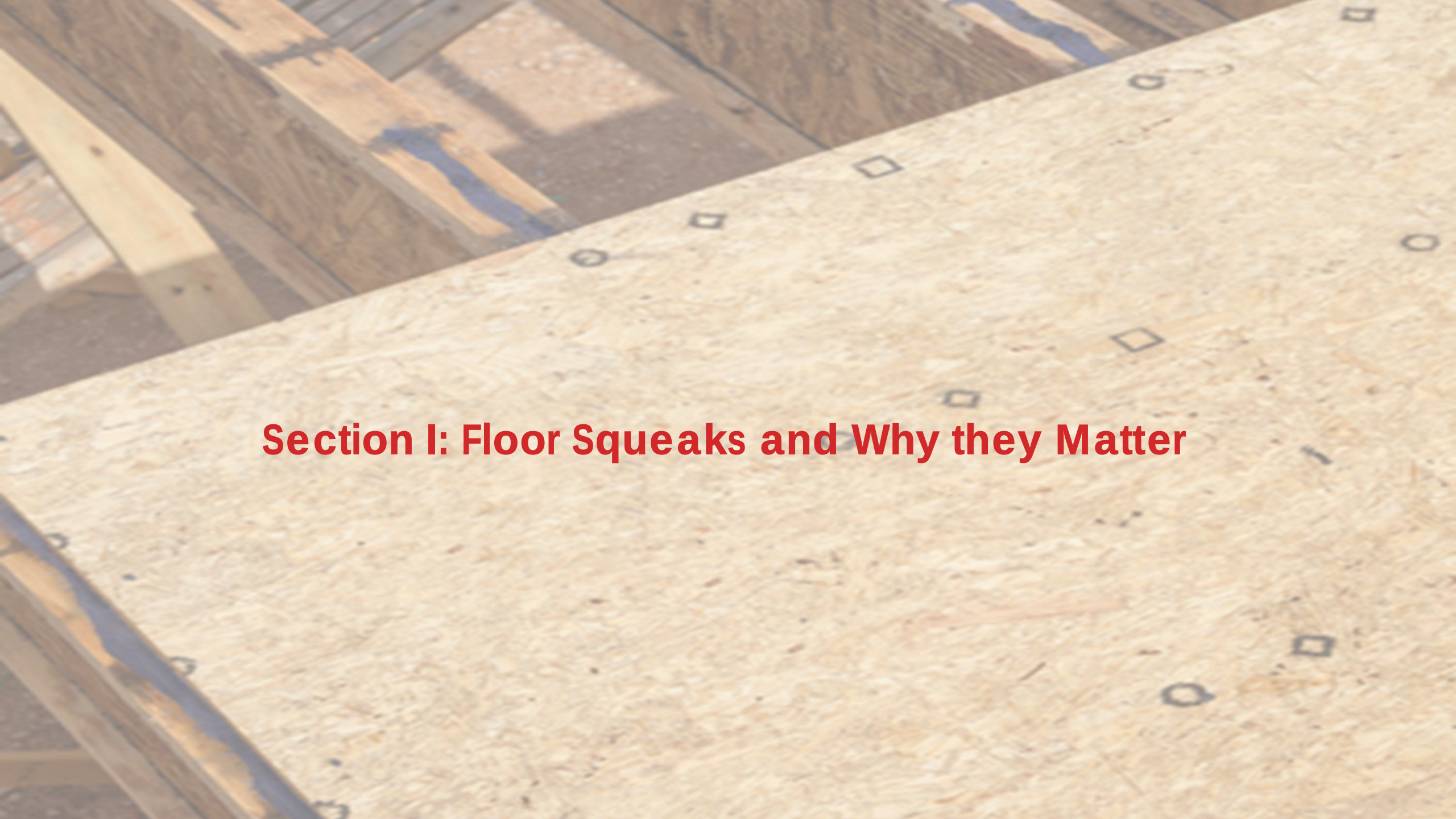
Addressing Wood Framed Floor Construction

Look at all aspects of a wood floor system:

- Floor Framing
- Subfloor
- Fasteners
- Subfloor Adhesive
- Mechanical Connections (hangers)
- Any structural steel present?

Agenda

- **Section I – Floor Squeaks and Why They Matter**
- **Section II Floor Framing**
  - A. Sizing, choices and challenges
- **Section III – Subfloor Panels**
  - A. High-Performance Engineered Panels during Construction
  - B. High-Performance Engineered Panels in Use
- **Section IV – Installing Subfloor Panels to Framing**
  - A. Adhesives
  - B. Mechanical Fasteners
- **Section V – Finish Flooring**
  - A. Choices and impacts
- **Conclusion**

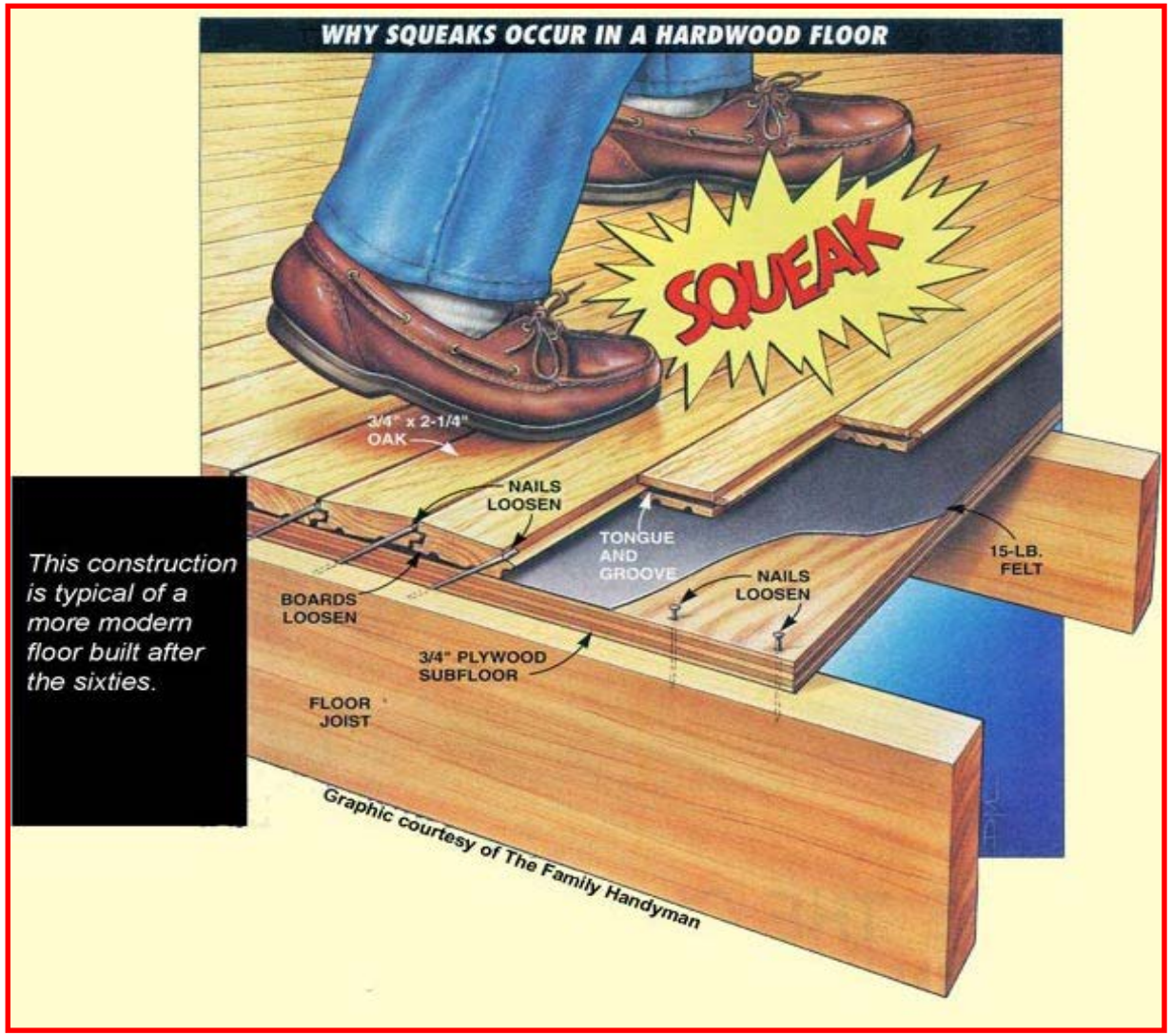


Section I: Floor Squeaks and Why they Matter

Floor Squeaks and Why They Matter

Sources of pops or squeaks

- Something moving in floor system
- Movement builds up internal stress or create friction between components.
- Sudden release of built up internal stress can result in a “pop” in the floor.
- Friction causes vibration which emanates sound.
- Eliminate the movement to eliminate squeaks.



Floor Squeaks and Why They Matter

Finish flooring and subfloor

- Movement in the subfloor can telegraph as movement in the finish flooring.

- Rigid finished floors, like tile and hardwoods, perform best on stiff and solid base.
-
- There is no point in putting a high quality, often costly finish material over an inadequate substrate.

- A quality flooring material should be installed over a quality subfloor system.

Floor Squeaks and Why They Matter

Why design to prevent floor squeaks?

- Achieve long-term durability
- Promotes owner satisfaction
- Reduce contractor call-backs – floors number 1 reason1
- Assure that there aren't issues with design, construction, or installation.
- Control professional liability/risk management

2007 J.D. Power New Homebuilder Customer Satisfaction Survey; 2006 ASHI Reporter article; 2017 Builder magazine "Common Callbacks"

Floor Squeaks and Why They Matter

How to design to prevent floor squeaks?

- Specify finish flooring, subflooring and framing products that are compatible.
- Specify subflooring that can withstand the anticipated weather exposure during construction.
- Provide good details of how components work together.
- Design the floor system to exceed code minimum deflection requirements.
- Specify an easy-to-use and high performance subfloor adhesive.

Section II: Floor Framing

Sizing, Selection and Challenges

Floor Framing

Floor System Design Criteria: Dimensional Lumber Example

Selection based on multiple criteria to achieve performance

Joist Spacing	Species and Grade	Dead Load=10 psf Maximum Floor Joist Spans			
16 o.c.	Spruce-Pine-Fir #2	2 x 6	2 x 8	2 x 10	2 x 12
		Ft.-in.	Ft.-in.	Ft.-in.	Ft.-in.
		9-4	12-3	15-5	17-10

Exerpted: IRC Table R502.3.1(2) Floor Joist Spans for Common Lumber. Live load =40 psf L/360 deflection.

Floor Framing: APA I-Joists

TABLE 11

ALLOWABLE SPANS FOR ***APA EWS*** PERFORMANCE-RATED I-JOISTS—SIMPLE SPAN ONLY[a,b,c,d,e]

		Simple Spans			
		On Center Spacing			
Depth	Joist Series	12"	16"	19.2"	24"
9-1/2"	PRI-20	16'-2"	14'-10"	14'-0"	13'-1"
	PRI-30	17'-1"	15'-7"	14'-9"	13'-9"
	PRI-40	17'-9"	16'-3"	15'-4"	14'-4"
	PRI-50	17'-10"	16'-4"	15'-5"	14'-5"
	PRI-60	18'-8"	17'-1"	16'-1"	15'-0"
11-7/8"	PRI-20	19'-3"	17'-8"	16'-8"	15'-7"
	PRI-30	20'-4"	18'-7"	17'-7"	16'-5"
	PRI-40	21'-2"	19'-4"	18'-3"	16'-8"
	PRI-50	21'-2"	19'-5"	18'-4"	17'-1"
	PRI-60	22'-2"	20'-3"	19'-2"	17'-10"
	PRI-70	23'-0"	20'-11"	19'-9"	18'-5"
	PRI-80	24'-6"	22'-4"	21'-0"	19'-7"
	PRI-90	25'-2"	22'-11"	21'-8"	20'-2"
16"	PRI-70	28'-10"	26'-4"	24'-10"	23'-1"
	PRI-80	30'-9"	28'-0"	26'-5"	24'-7"
	PRI-90	31'-7"	28'-9"	27'-1"	25'-3"

a. Allowable **clear** span applicable to simple-span residential floor construction with a design dead load of 10 psf and live load of 40 psf. The live load deflection is limited to span/480.

b. Spans are based on a composite floor with glued-nailed sheathing meeting the requirements for APA Rated Sheathing or APA Rated STURD-I-FLOOR conforming to PS 1, PS 2, CSA O325, or CSA O437 with a minimum 19/32 Performance Category (40/20 or 20 oc) for a joist spacing of 19.2 inches or less, or 23/32 Performance Category (48/24 or 24 oc) for a joist spacing of 24 inches. Adhesive shall meet ASTM D3498 or APA Specification AFG-01. Spans shall be reduced 12 inches when the floor sheathing is nailed only.

c. Minimum bearing length shall be 1-3/4 inches for the end bearings.

d. Bearing stiffeners are not required when I-joists are used with the spans and spacings given in this table, except as required by hanger manufacturers.

e. This span chart is based on uniform loads. For applications with other than uniformly distributed loads, an engineering analysis may be required based on the use of the design properties in Table 7 of *APA Performance Rated I-Joists*, Form Z725.

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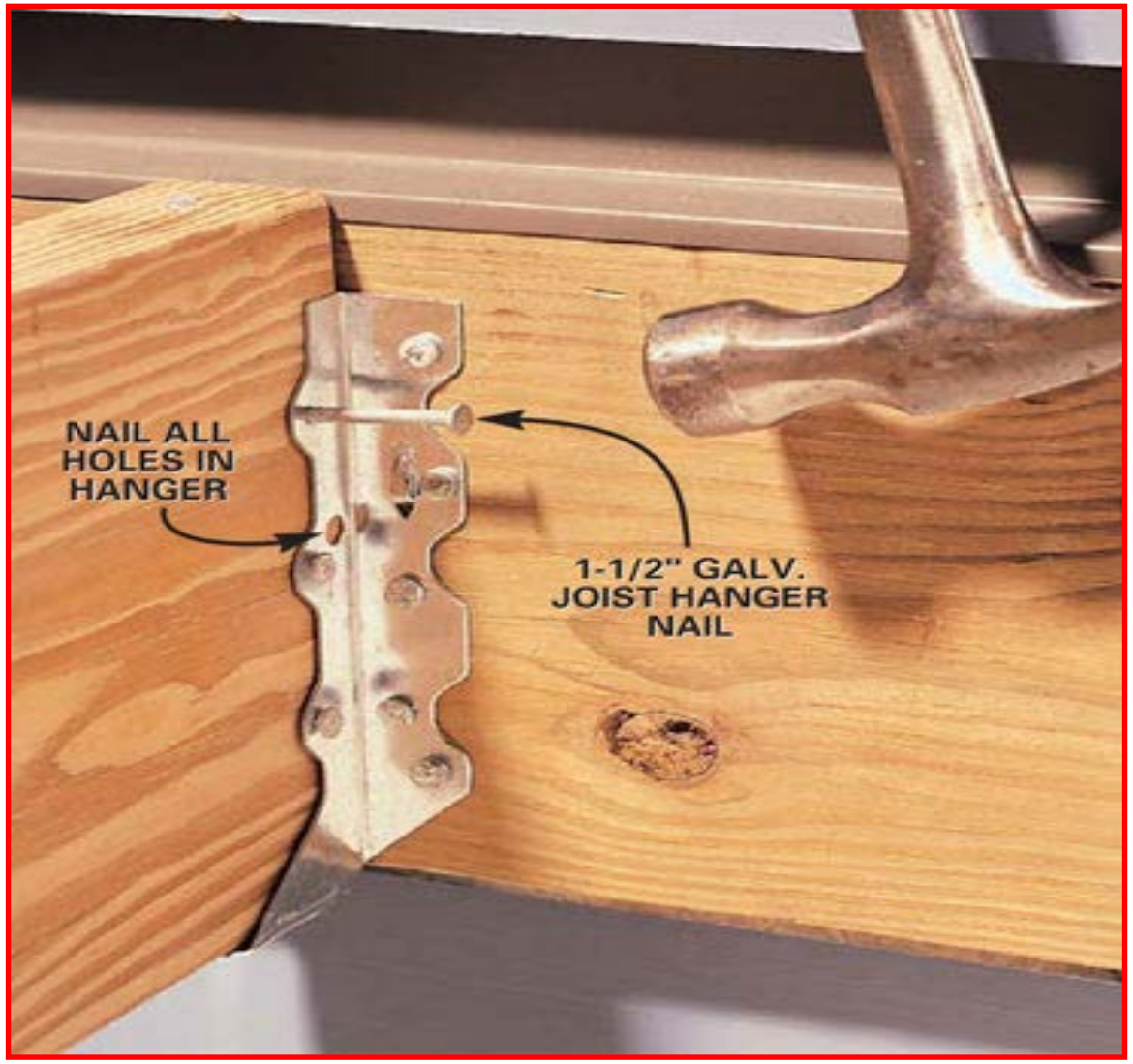
Floor Framing

Limitations of dimensional 2 x framing

- No two pieces of lumber framing are alike.
- Natural defects like wane and knots can occur in lumber framing that do not occur in engineered joists.
- Natural lumber can dry and shrink during construction especially when the load is perpendicular to the grain like in floor joists.
- Deep lumber joists are prone to a cup in cross section which can lead to squeaky hangers.

Floor Framing

- Metal joist hangers are common for dimensional lumber, I-joists, and floor trusses.
- Proper hanger specification is essential.
- Can’t skip fasteners – missing fasteners means reduced strength and stability.
- Insufficient fastening could allow joist bearing end to rotate inside the hanger causing squeaks.



Floor Framing

Mechanical / Electrical / Plumbing

- M/E/P trades often cut framing to perform their work.
- Floor framing can be drastically weakened if cut in the wrong location.
- Open web floor trusses offer openings many openings for M/E/P.

Section III: Subfloor Panels

A: Material Choices

B. High Performance Panels During Construction

C. High Performance Panels in Use

Subfloor Panels

Material choices for subfloor

- Historically – lumber boards installed on an angle across floor framing.
- In mid 1900's - engineered plywood became prevalent.
- Late 1970s- oriented strand board was developed as a wood structural panel with performance equivalent to plywood.
- 1997- High performance wood structural panels introduced as subflooring options with performance greater than plywood or OSB.

High Performance Subfloor Panels in Use

Categories of Panel Thickness – DOC PS-2

Panel Thickness Requirements*		
PERFORMANCE CATEGORY	MINIMUM THICKNESS, in. (mm)	MAXIMUM THICKNESS, in. (mm)
7/16 PERF CAT	.406 (10.32)	.469 (11.91)
1/2 PERF CAT	.469 (11.91)	.531 (13.49)
5/8 PERF CAT	.594 (15.08)	.656 (16.67)
19/32 PERF CAT	.563 (14.29)	.625 (15.88)
23/32 PERF CAT	.688 (17.46)	.75 (19.05)
7/8 PERF CAT	.831 (21.11)	.919 (23.34)
1 PERF CAT	.950 (24.13)	1.05 (26.67)
1-1/8" PERF CAT	1.069 (27.15)	1.181 (30.00)

*PS2-10, Table 1

Subfloor Panels

Plywood Subfloor Systems

- Plywood subfloor systems have their limitations.
- Moisture absorption is high on this type of panels.
- Waterproof adhesive used for plywood construction creates huge delays in panel drying and lengthens production schedule.

Source: National Wood Floor Consultants, Inc. 2016

High Performance Subfloor Panels During Construction

Water Resistance Testing

- Subfloor panel soak test
- Results show progress of water penetration through the 3-hour test.

Plywood panel edge test

High performance panel edge test

Subfloor Panels

Plywood Subfloor

- Water absorption is high.
- Prone to delamination but more resistant to edge swell than OSB.
- Not all plywood is equal. Species used in the construction plays a important role in performance.

Source: National Wood Floor Consultants, Inc. 2016

Subfloor Panels

OSB Subfloor Systems

Oriented Strand Board (OSB) Grades

- Commodity Grade
- Mid-Level Grade
- High Performance Grade

Source: National Wood Floor Consultants, Inc. 2016

Subfloor Panels

High Performance Engineered Wood Panels

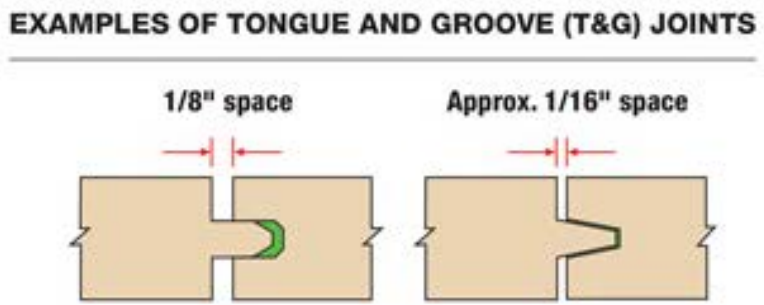
- More dimensionally stable than typical OSB or plywood.
- Higher strength and stiffness properties
- Better moisture resistance
- Greater fastener-holding power

Regular OSB **High Performance Panels**

High Performance Subfloor Panels During Construction

Tongue and Groove Profile

- Typical OSB and plywood rely on “wedge” style profiles.
  - Wedge T&G creates friction fit, accumulating of stresses between the panels.
  - Stress build up can result in noise between panels.
- T&G profiles should fit snug but not tight.
- Gaps between panels should be maintained by the T&G.



Regular OSB / plywood

High Performance Panels with integral spacer

High Performance Subfloor Panels During Construction

Water Resistance

- OSB and plywood susceptible to water absorption, causing swollen edges or delamination.
- Common fix for swollen edges is to sand the panel surface.
- High-performance panels are engineered to resist the negative effects of water during construction.

High Performance Panels perform under jobsite conditions

High Performance Subfloor Panels During Construction

Water Resistance

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- High-performance panels are engineered to resist the negative effects of water during construction.

Plywood after wet/dry cycles

High Performance Subfloor Panels in Use

Strength and Stiffness

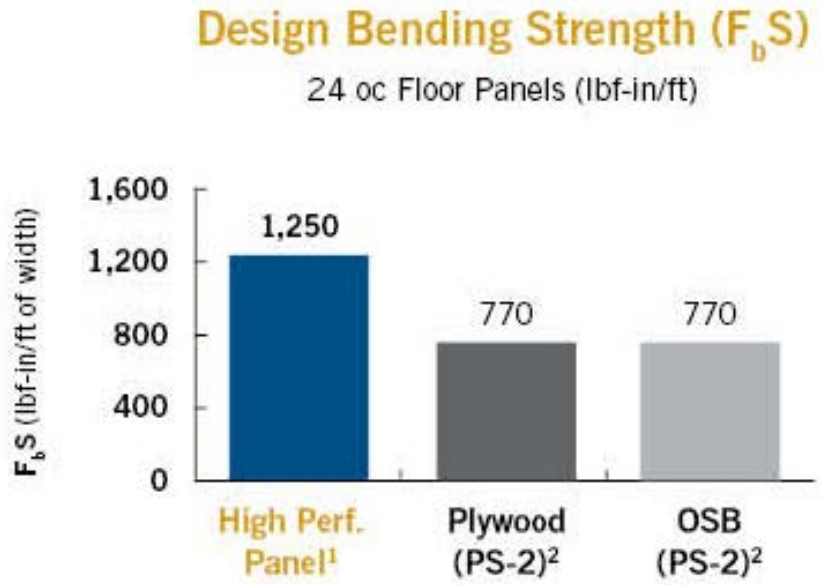
- High Performance Engineered wood subfloor panels are engineered to be stronger and more stiff.
- Less likely to sag which creates a higher perception of quality
- Less “bounce” when people walk on floor
- Less deflection for finished floors
- Less chance of squeaks at non-load bearing walls

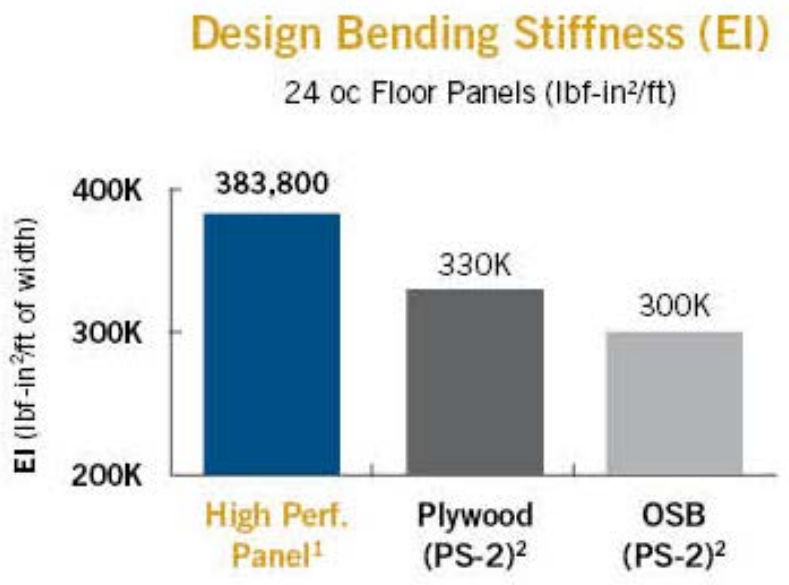
High Performance Subfloor Panels in Use

Verifying Performance

- Typical High-Performance panel vs OSB and Plywood
  - 62% stronger than OSB and Plywood.
  - 16% more stiff than Plywood
  - 28% more stiff than OSB

ICC EVALUATION SERVICE





High Performance Subfloor Panels in Use

What causes flooring noise?

- Subfloor strength properties
- Non-flat subfloors
- Deflection in subfloors
- Loose subfloors
- Lack of adhesive
- Hardwood floor concerns
- Side match (manufacturing)
- Water damage/Cupping
- Mechanical fasteners

NWFC Source: National Wood Floor Consultants, Inc. 2016

High Performance Subfloor Panels in Use

Not-flat subfloors / / Flat, not level

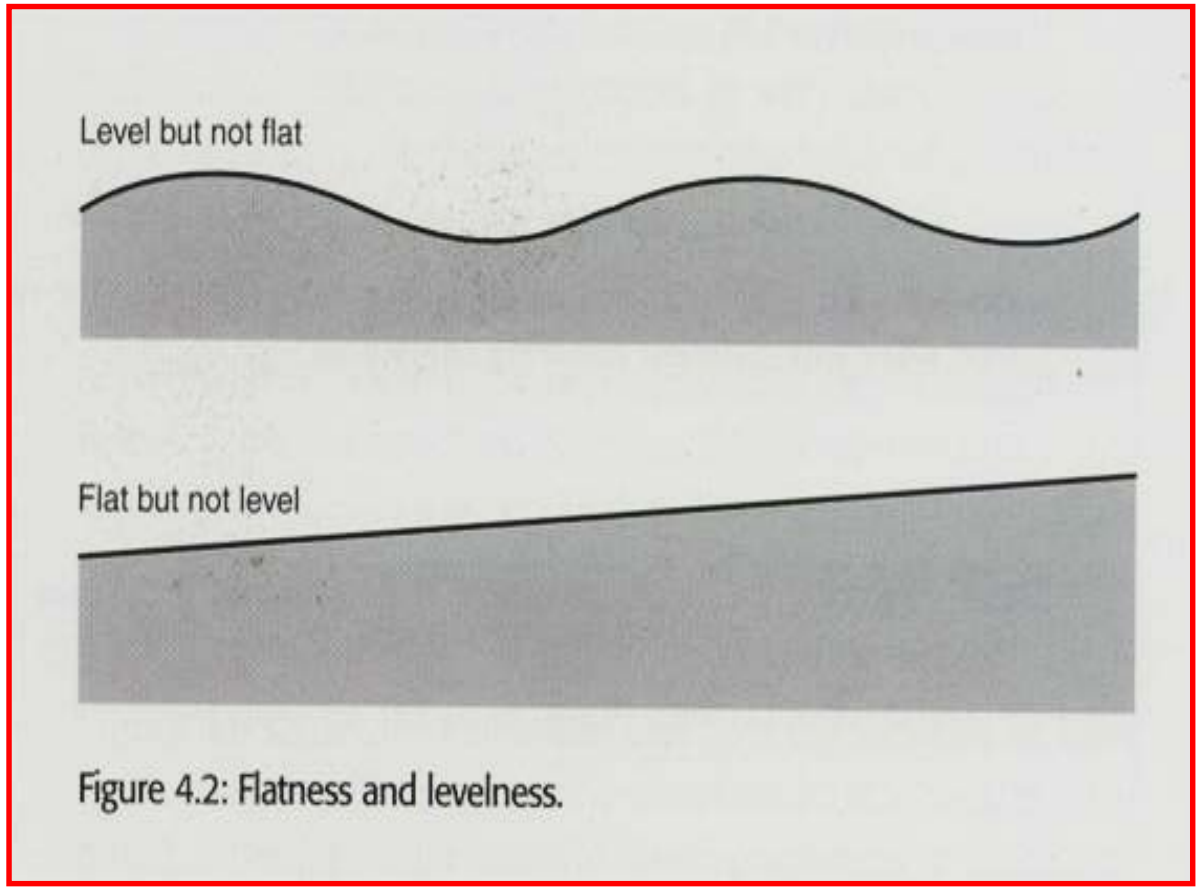
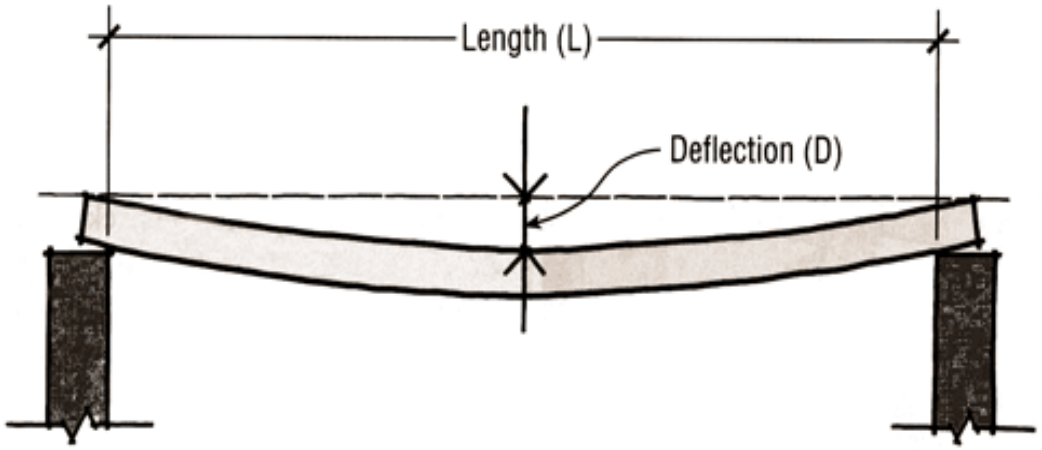


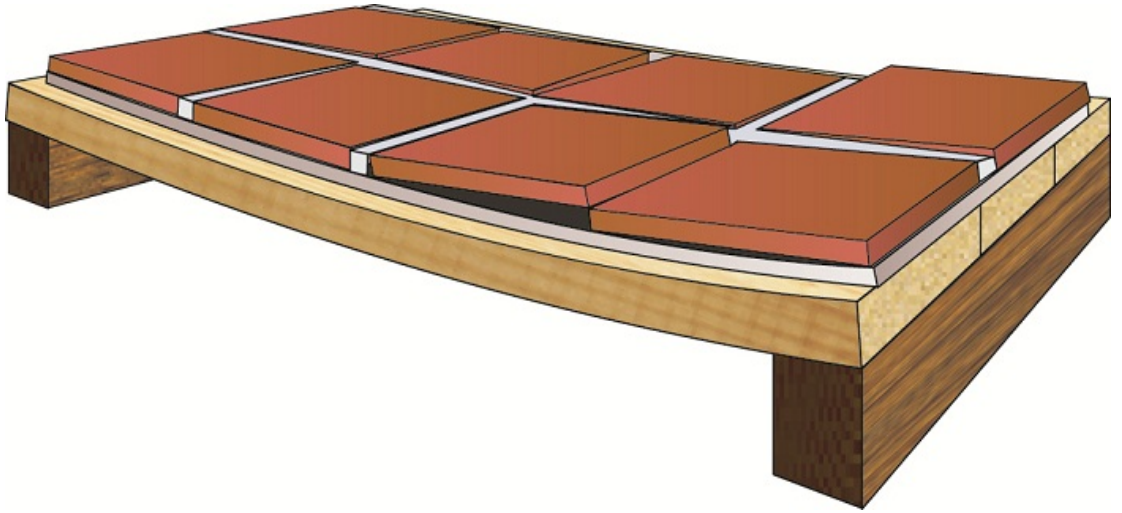
Figure 4.2: Flatness and levelness.

NWFC Source: National Wood Floor Consultants, Inc. 2016

High Performance Subfloor Panels in Use

Subfloor Panel Deflection / / Calculating Deflection





Maximum allowable deflection (D) for joists is equal to L/360

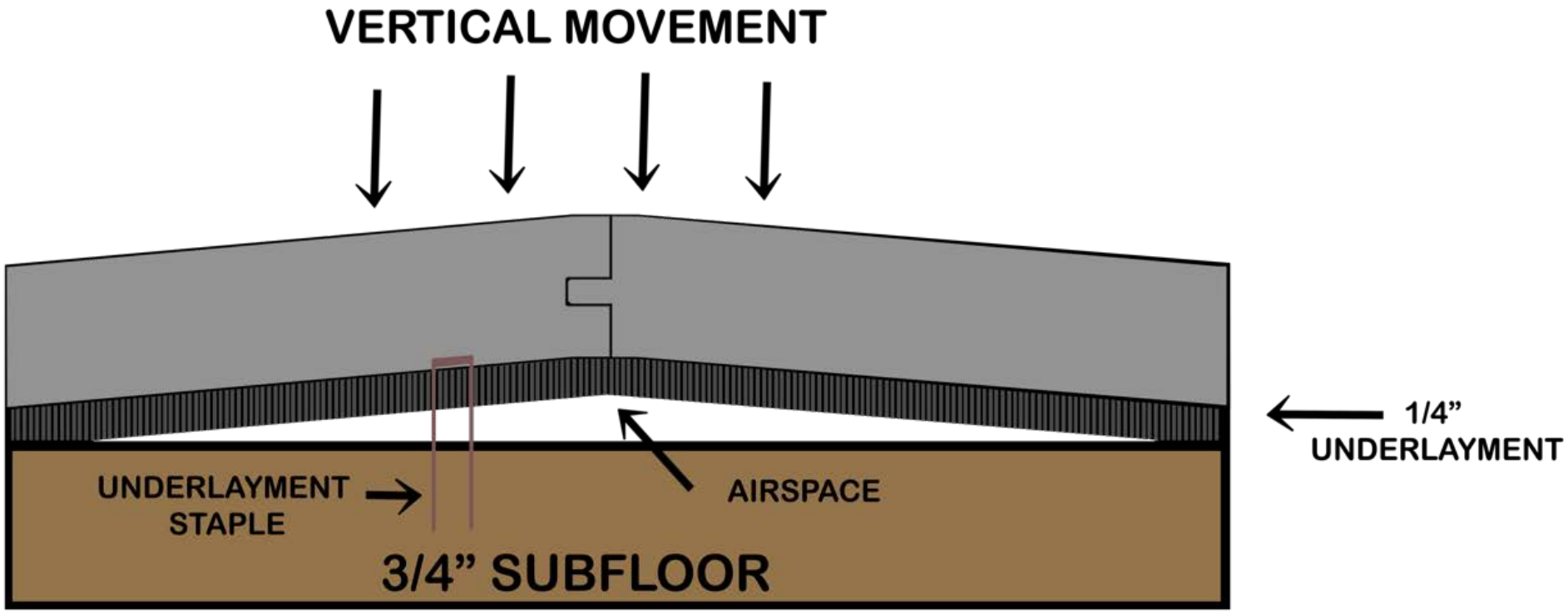
For example, if L = 20'-0":

$$\text{Deflection (D)} = \frac{L}{360} = \frac{20' \times 12"}{360} = \frac{240"}{360} = .666" \cong 5/8"$$

NWFC Source: National Wood Floor Consultants, Inc. 2016

High Performance Subfloor Panels in Use

Non-flat Underlayments



Source: National Wood Floor Consultants, Inc. 2016

High Performance Subfloor Panels in Use

Loose Subfloors

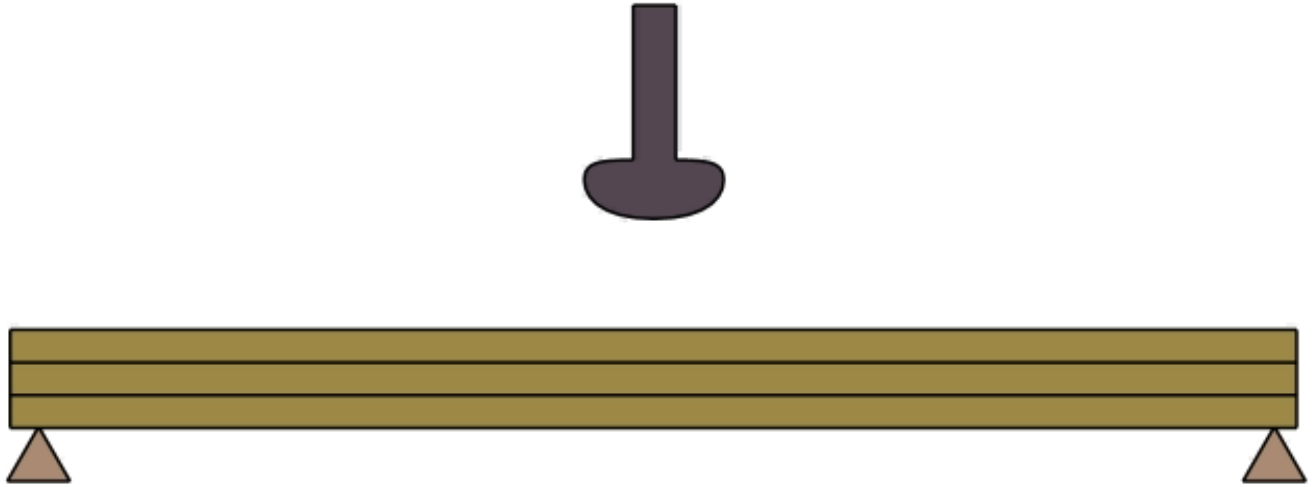
Loose subfloors can result from fasteners missing the floor joist/trusses during installation of panels.

Source: National Wood Floor Consultants, Inc. 2016

High Performance Subfloor Panels in Use

Loose Subfloors

- Q: Why is the industry standard to glue panels to floor joists?
- A: Prevent squeaks by eliminating “shear slip” between panel and joist making the joist more stiff than with just fasteners alone.



NWFC Source: National Wood Floor Consultants, Inc. 2016

Subfloor Panels

Composite Action

- Composite construction occurs when two separate materials are bound together so strongly that they act as though they are one homogenous component.

- Composite action makes two components greater than the sum of their parts.

http://www.steelconstruction.info/Shear_connection_in_composite_bridge_beams

High Performance Subfloor Panels in Use

Subfloor with Hardwood floors Noise Solutions

- Full spread direct glue down application for hardwood flooring (1.00 SF upcharge to cover materials)
- Sell thicker hardwood flooring materials with longer lengths (approx. 1-2.00 SF).
- Blocking between joists/truss every 24” O.C. (approx. 1.00 SF cover labor and blocking materials).
- Upgrade subfloor panel quality or thickness for better fastener retention and less deflection (approx. upcharge between .38 to .50 SF)

NWFc Source: National Wood Floor Consultants, Inc. 2016

Section IV: Fastening Subfloor Panels to Framing

A: Adhesives

B. Mechanical Fasteners

Fastening Subfloor Panels to Framing :: Adhesives

- Connection is critical
- Fasteners plus adhesive creates composite action
- Reduces movement and squeaks

Fastening Subfloor Panels to Framing :: Adhesives

Conventional Adhesives

- Assures continuous bond
- Different types of adhesives available
- Mechanically squeezed cartridges have some limitations.
  - Difficult to control – uneven bonding
  - Temperature sensitive – compromised bonding
  - Difficult to install can lead to poor coverage

Fastening Subfloor Panels to Framing :: Adhesives

- Spray-foam Adhesives
- Moisture cured spray foam adhesive bonds to wet and frozen lumber.
- Fast and easy to install
- Spray foam gun applicator provides more measured output.
- 8-10x yield
- Works well in wet and cold weather
- If it is easy to install, coverage and application will be better.

Fastening Subfloor Panels to Framing :: Mechanical

Why use fasteners?

- Use Mechanical fasteners in conjunction with adhesives while bonding takes place.

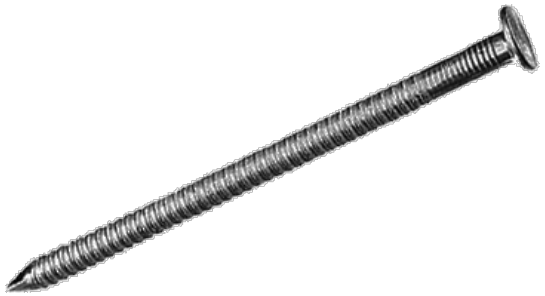
- Combination helps assure immediate and long term bond for strength, stiffness, and squeak resistance

- Proper fastening and fully gluing subfloor to framing can eliminate squeak at the panel to joist connection.

Fastening Subfloor Panels to Framing :: Mechanical

Options

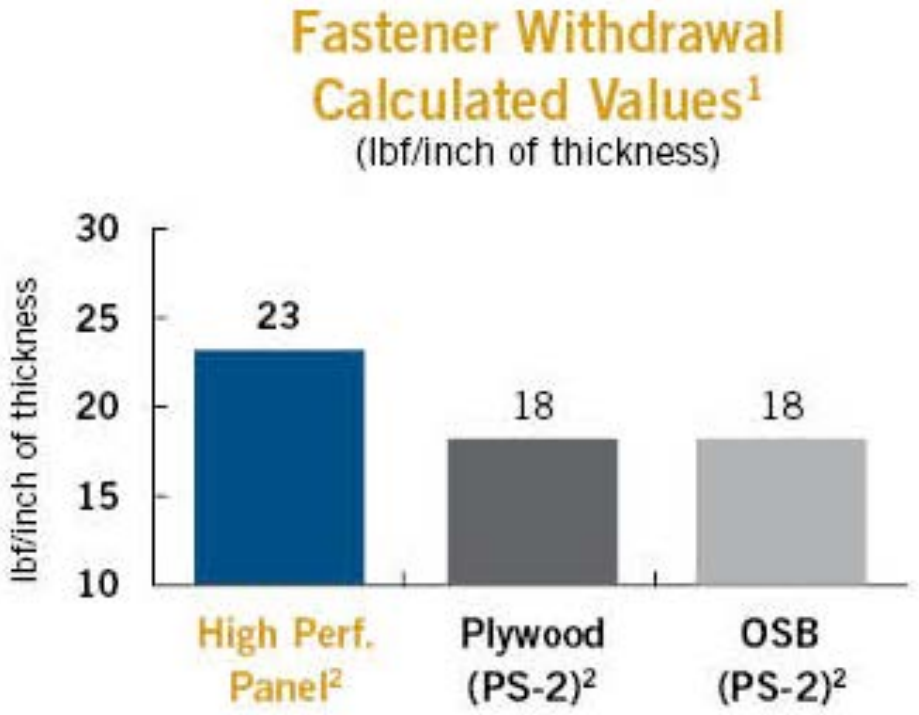
- Screws have greatest holding power.
- Smooth shanked nails can back out as wood dries.
- Ring shank or screw shank nails provide more friction to resist pullout.



Fastening Subfloor Panels to Framing :: Mechanical

How tight is your grip?

- Some high performance engineered wood subfloor panels have been tested to demonstrate greater Equivalent Specific Gravity, fastener holding power, for mechanical fasteners compared to plywood or conventional OSB.

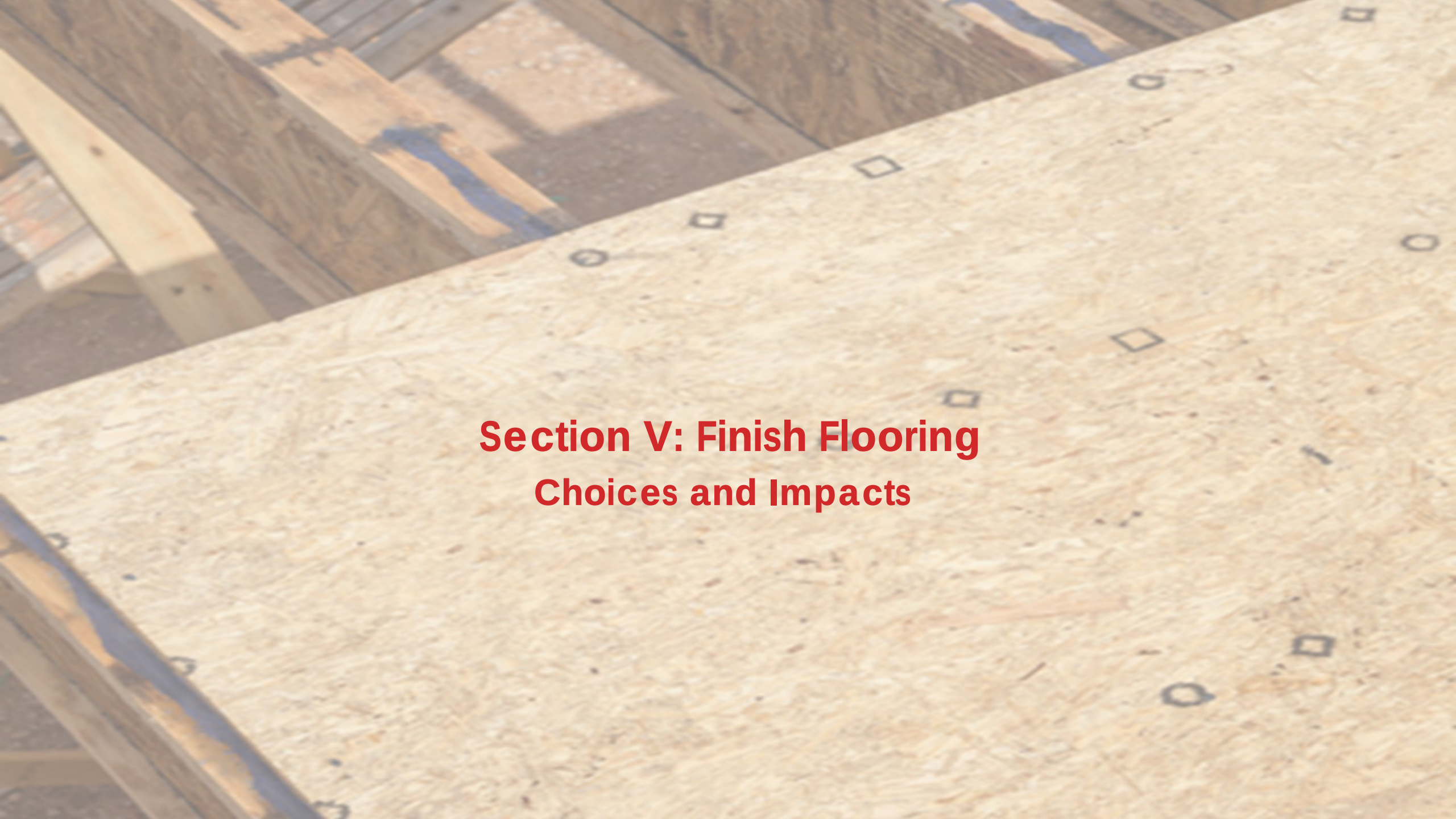


Fastening Subfloor Panels to Framing :: Mechanical

- Fastener spacing
- Too few fasteners can lead to reduced floor shear (diaphragm) capacity and squeaks.
- Code minimum is 6 inch spacing along edges and 12 inches at intermediate supports.
- Pre-printed panels help assure proper spacing for structural strength and bonding.

Fastening Subfloor Panels to Framing :: Mechanical

- Fasteners need to properly penetrate into the framing beneath the subfloor
- Near misses or exposed fasteners below can rub on framing and cause squeaks



Section V: Finish Flooring

Choices and Impacts

Finish Flooring

- Relationship to subfloor
- Finished floor is directly influenced by subfloor performance.
- Proper subfloor installation is critical before finished floor installation.
- Isolate or minimize subfloor movement.

Finish Flooring

Wood Flooring

- Must be acclimated to conditioned space.
- Moisture differential between hardwood and subfloor is a concern.
- Proper fastening of wood floor required.
- Follow National Wood Flooring Association guidelines:

https://www.nwfa.org/

Finish Flooring

Tile Flooring (Ceramic or Porcelain)

- Underlayment usually required, fastened securely and permanently
- Subfloor stiffness is important to avoid tile cracks.
- Many tile underlayment options are available. Follow manufacturer instructions.
- Follow “Tile Council of North America” guidelines.

http://www.tcnatile.com/

Finish Flooring

Match Subfloor to Finish Floor

- OSB and plywood are sufficient for carpet.
- OSB and plywood are sufficient for sheet vinyl but proper underlayment must be used.

Finish Flooring

Matching Subfloor to Finish Floor

Brittle or hard finishes, like tile, marble and hardwood, require minimum deflection which can be achieved by using:

- Thicker subfloor panels
- High performance subfloor panels with elevated stiffness design values.
- Tighter joist spacing
- Shorter joist spans
- Full composite action between panel and joist. Specify a high-strength and easy to use adhesive.

Conclusions

Conclusions

Specify High Performing Floor Systems

To meet high quality expectations for a solid, quiet flooring base, use a combination of:

- Appropriately selected floor framing
- High performance engineered wood subfloor panels
- Installed with polyurethane spray-foam adhesive and screws or deformed shank nails

Conclusions

Products with enhanced capabilities

- Demonstrated moisture resistance
- Increased strength, and stiffness
- Tight flatness tolerances at manufacturing.

The final result: a quality project that will hold up over time for designers, owners and end users.

This Concludes the Huber Engineered Woods LLC, AIA/CES, Continuing Education System Course

Thank you for participating.

For more information contact:
Ryan.Stephenson@Huber.com
Brian.Shores@Huber.com
Don.Simon@Huber.com

Email: Techquestions@Huber.com

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