# Acoustic Performance of All-Wood Floor Systems

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## 1. INTRODUCTION

Lightweight concrete and gypcrete toppings are frequently installed over engineered wood floor systems in multifamily and commercial construction. Such composite floor systems are typically constructed as fire-rated assemblies with code-compliant fire and acoustic performance. In recent years, the wood structural panel (WSP) industry has developed all-wood floor systems that use single- or double-layer floor sheathing meeting both fire and acoustic performance requirements without the use of concrete or gypcrete topping.

These all-wood floor systems employ thick subfloor sheathing, such as a single layer of 1-1/8 Performance Category Panel or double layers of 19/32 Performance Category top layer over 23/32 Performance Category base layer. Conventional light-frame floor construction is typically constructed with a single layer of 23/32 Performance Category floor sheathing. All-wood floor systems have the advantage of speedy construction because they eliminate construction delays caused by the installation of lightweight concrete or gypcrete topping. In addition, these floors are stiffer than conventional light-frame floors.

In supporting the development of all-wood floor systems without lightweight gypcrete or concrete topping, APA conducted a series of acoustic tests for code compliance based on sound transmission class (STC) and impact insulation class (IIC) ratings. Detailed descriptions for STC and IIC ratings are provided in APA *Design/Construction Guide: Noise-Rated Systems*, Form W460. The results are presented in this publication. The double-layer floor assembly (19/32 Performance Category top layer over 23/32 Performance Category base layer) provides similar acoustic performance to the single-layer (1-1/8 Performance Category) floor assembly.

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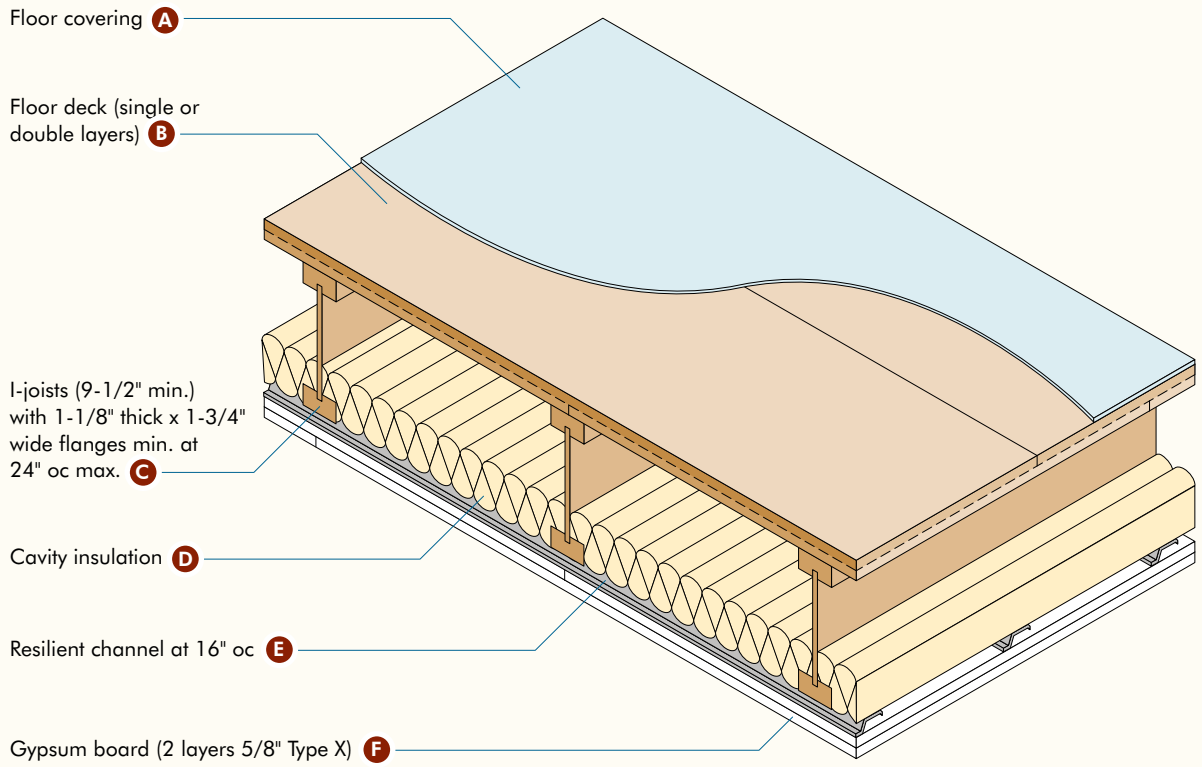
## 2. DESCRIPTIONS OF ASSEMBLIES

The all-wood floor assembly is depicted in Figure 1.

FIGURE 1

**CROSS-SECTION OF ALL-WOOD FLOOR ASSEMBLY**




**A** A variety of floor covering materials are available (see Table 1 for STC and IIC ratings). For vinyl tiles, quarry tiles, and hardwood flooring, a sound mat should be installed between the floor covering and floor sheathing.

1. **Cushioned vinyl:** Vinyl sheet flooring with 0.145 inch in minimum thickness and 0.53 psf in minimum weight
2. **Vinyl tile:** 0.19 inch in minimum thickness and 2.21 psf minimum over 5-mm sound mat (ECOsilence 5, 0.198 inch or 5 mm in thickness and 0.78 psf in weight)
3. **Quarry tile:** 0.5 inch in minimum thickness and 5.6 psf minimum weight attached to 5-mm sound mat (ECOsilence 5, 0.198 inch or 5 mm in thickness and 0.78 psf in weight) using thin-set mortar
4. **Hardwood flooring:** 0.38 inch in minimum thickness and 1.12 psf in minimum weight over 5-mm sound mat (ECOsilence 5, 0.198 inch or 5 mm in thickness and 0.78 psf in weight)
5. **Carpet and pad:** 44-ounce carpet with 0.438 inch in minimum thickness and 0.56 psf in minimum weight over a foam rubber pad of 0.375 inch in thickness and 0.48 psf in weight

**B** Wood structural panel floor sheathing meeting the code requirements should be installed perpendicular to the I-joist framing. It is not required to glue the floor sheathing to the I-joist framing. For structural performance, however, the designer may require the floor sheathing to be glued to the I-joist framing.

1. **For the single-layer floor system,** 1-1/8 Performance Category tongue-and groove floor sheathing should be used with fasteners at 6 inches on center or less in the sheathing perimeter and 12 inches on center or less in the field.

2. **For the double-layer floor system,** the base layer of 23/32 Performance Category tongue-and groove floor sheathing should be used with fasteners at 6 inches on center or less in the sheathing perimeter and 12 inches on center or less in the field. The face layer of 19/32 Performance Category may be square edged, and should be laid over the base layer sheathing (staggered in accordance with *APA Engineered Wood Construction Guide*, Form E30) with fasteners at 6 inches on center or less in the sheathing perimeter and 12 inches on center or less in the field.

**C** Prefabricated wood I-joists of 9-1/2 inches in depth minimum, with a flange size of 1-1/8 inches in thickness by 1-3/4 inches in width minimum, at a maximum joist spacing of 24 inches on center.

**D** A 3-1/2-inch thick R-13 fiberglass batt insulation should be installed in the joist cavities with the exception of the assembly that is covered by cushioned vinyl, in which a layer of 3-inch thick mineral wool (2.8 pcf) insulation should be installed instead.

**E** RC-1 resilient channels (0.017-inch thick) should be installed perpendicular to the bottom of the I-joist flanges at 16 inches on center with 1-1/4-inch Type W drywall screws.

**F** Two layers of 5/8-inch Type X gypsum boards complying with ASTM C1396 should be attached perpendicular to the resilient channels with 1-inch and 1-5/8-inch Type S drywall screws at 12 inches on center for the base and face layers of gypsum boards, respectively.

## 3. ACOUSTIC PERFORMANCE REQUIREMENTS

The 2015 International Building Code (IBC) specifies a minimum STC rating of 50 for walls, partitions, and floor-ceiling assemblies between adjacent dwelling units and sleeping units or between dwelling units and sleeping units and adjacent public areas when tested in accordance with ASTM E90, *Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements*, and analyzed in accordance with ASTM E413, *Classification for Rating Sound Insulation*. The 2015 IBC also specifies a minimum IIC rating of 50 when tested in accordance with ASTM E492, *Standard Test Method for Laboratory Measurement of Impact Sound Transmission through Floor-Ceiling Assemblies Using the Tapping Machine,* and analyzed in accordance with ASTM E989, *Standard Classification for Determination of Impact Insulation Class (IIC).* The 2015 International Residential Code (IRC) stipulates a rating of 45 for both STC and IIC in the non-mandatory Appendix K.

## 4. ACOUSTIC PERFORMANCE

The STC and IIC ratings for the assemblies described above are provided in Table 1 based on the results of acoustic tests conducted at an accredited independent acoustics laboratory. The STC rating is determined in accordance with ASTM E90 and ASTM E413, and the IIC rating is determined in accordance with ASTM E492 and ASTM E989.

TABLE 1

**STC AND IIC RATINGS FOR SINGLE- AND DOUBLE-LAYER FLOOR ASSEMBLIES[a]**

| **Description** | **Single-layer floor assembly** | **Double-layer floor assembly** |
|---|---|---|
| Base layer (Wood structural panel sheathing) | 1 1/8 | 23/32 |
| Top layer (Wood structural panel sheathing) | NA | 19/32 |
| **Floor covering** | **STC (ASTM E90 and E413)** | |
| NA (bare floor) | 53 | 55 |
| **Floor covering** | **IIC (ASTM E492 and E989)** | |
| Cushioned vinyl | 51 | 51 |
| Vinyl tile with sound mat | 51 | 50 |
| Quarry tile with sound mat | 52 | 55 |
| Hardwood flooring with sound mat | 53 | 50 |
| Carpet and pad | 69 | 67 |

a. See Sections 2 and 5 of this publication for detailed descriptions of the assemblies and interpretation, respectively.

As shown in Table 1, the STC and IIC ratings for these assemblies are well within the range of acceptable ratings for multifamily residential and nonresidential buildings. The STC ratings are based on the bare floor without the addition of floor covering. However, the STC ratings are not typically affected by finished flooring except when the flooring adds significant mass. Therefore, the actual performance of the floor assemblies with a floor covering may be slightly better than the STC ratings tabulated in Table 1. Note that the tabulated STC and IIC ratings assume that recognized precautions are taken for preventing flanking noise and sound leaks, and provided that the construction conforms to the assemblies described above.

*Quality of workmanship, material and conditions at the site may vary widely. Because APA – The Engineered Wood Association has no control over these elements, it cannot warrant or assume responsibility for performance to rated levels. In addition, the STC and IIC ratings may not guarantee acceptable performance to all occupants.*

## 5. INTERPRETATION

In interpreting these results, there are some modifications that can be made without a discernable change in sound insulating properties.

1. Any prefabricated wood I-joists conforming to ASTM D5055 can be used, provided that the joists are 9-1/2 inches or deeper, the flange size is at least 1-1/8 inches in thickness by 1-3/4 inches in width, and spaced a maximum of 24 inches on center.
2. Plywood, oriented strand board (OSB), and composite panel floor sheathing conforming to DOC PS1 or PS2 are interchangeable on a thickness-for-thickness basis.
3. Wood structural panels of 19/32 and 5/8 Performance Categories are interchangeable, and 23/32 and 3/4 Performance Categories are interchangeable.
4. A 3-inch mineral wool insulation (2.8 pcf) can substitute for 3-1/2-inch thick R-13 fiberglass insulation.

## 6. FIRE RATING

The floor-ceiling assemblies described above are required to be installed with 2 layers of 5/8-inch Type X gypsum boards at the exposed side of the assemblies. These assemblies can be assigned a 1-hour fire rating based on the component additive method prescribed in Section 722.6 of the 2015 IBC. As a comparison, these assemblies are practically the same as the 1-hour fire-rated floor-ceiling assembly listed in Item 21-1.1 of Table 721.1(3) of the 2015 IBC.

## 7. REFERENCES


1. APA – The Engineered Wood Association. 2016. *Engineered Wood Construction Guide*, Form E30. Tacoma, WA.
2. ASTM International. *Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements*. ASTM E90(2016). West Conshohocken, PA.
3. ASTM International. *Classification for Rating Sound Insulation*. ASTM E413-16. West Conshohocken, PA.
4. ASTM International. *Standard Test Method for Laboratory Measurement of Impact Sound Transmission through Floor-Ceiling Assemblies Using the Tapping Machine*. ASTM E492-09(2016)e1. West Conshohocken, PA.
5. ASTM International. *Standard Classification for Determination of Impact Insulation Class (IIC)*. ASTM E989-06(2012). West Conshohocken, PA.
6. International Code Council. 2015. *International Building Code*. Country Club Hills, IL.
7. International Code Council. 2015. *International Residential Code*. Country Club Hills, IL.

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