Designing and Detailing Mass Timber Projects for Acoustic Performance

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Timber House / MESH Architectuer / Photo Travis Mark

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Course Description

Effective acoustic performance is an essential component of successfully designed buildings; however, designing for acoustics in mass timber structures is unique compared to other construction types. As more mass timber structures have been built, the body of knowledge on proven methods for achieving acoustic performance has also grown. This presentation will provide background on the challenges of achieving appropriate sound control in mass timber structures and an overview of key code considerations. Experts will discuss testing requirements, strategies, results, and practical design techniques for meeting acoustic requirements. They'll also share examples of proven detailing strategies and potential modifications to the details for future projects.

Learning Objectives

1. Discuss code requirements related to acoustics in various building occupancies and the unique acoustical concerns related to mass timber buildings.

2. Explore acoustical testing methods, standards, and results for mass timber structures and discuss how to achieve code-compliant assemblies.

3. Review methods of achieving effective acoustic performance in mass timber structures, including examples of proven detailing strategies.

4. Highlight methods of acoustic detailing utilized in a constructed multi-family project, including a discussion of which details will be reused and any updates to the previous detailing strategies.

“Unnecessary noise is the cruelest absence of care.”

—Florence Nightingale

Noise **Acoustics** **Sound Pollution**

Whatever you call it, it all comes down to one thing:

Occupant Comfort

Acoustical Design

Types of noise to control: **Exterior to interior**

Acoustical Design

Types of noise to control: **Noise within a space**

Room Acoustics

What is Sound Absorption?

All materials absorb sound energy to some degree. Whenever sound waves strike a material, part of the acoustical energy in the wave is absorbed and/or transmitted, and the remainder is reflected.

Arena Stage, Washington, DC

Photo: Nic Lehoux, Bing Thom Architects

Room Acoustics

What is the Noise Reduction Coefficient (NRC)?

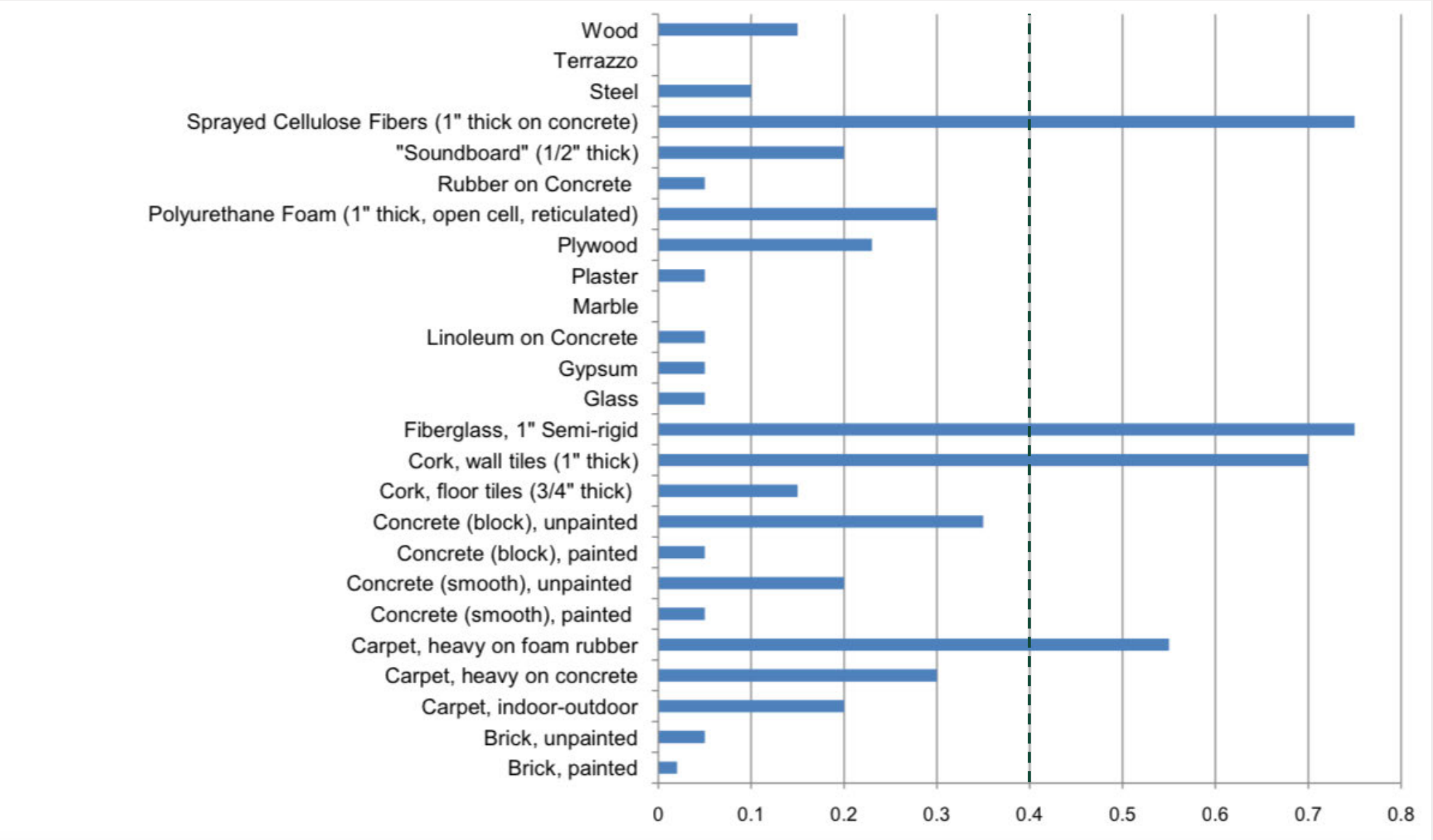
A material's sound absorbing capabilities often expressed by a single number NRC (Noise Reduction Coefficient) rating.

NRC is the average of the sound absorption coefficients measured at 250, 500, 1000, and 2000 Hz rounded off to the nearest 0.05.

Materials with an NRC greater than 0.40 are usually considered sound absorbers.

Tippet Rise Olivier Music Barn
Photo: Alban Bassuet

NOISE REDUCTION COEFFICIENTS (NRC) FOR COMMON BUILDING MATERIALS:

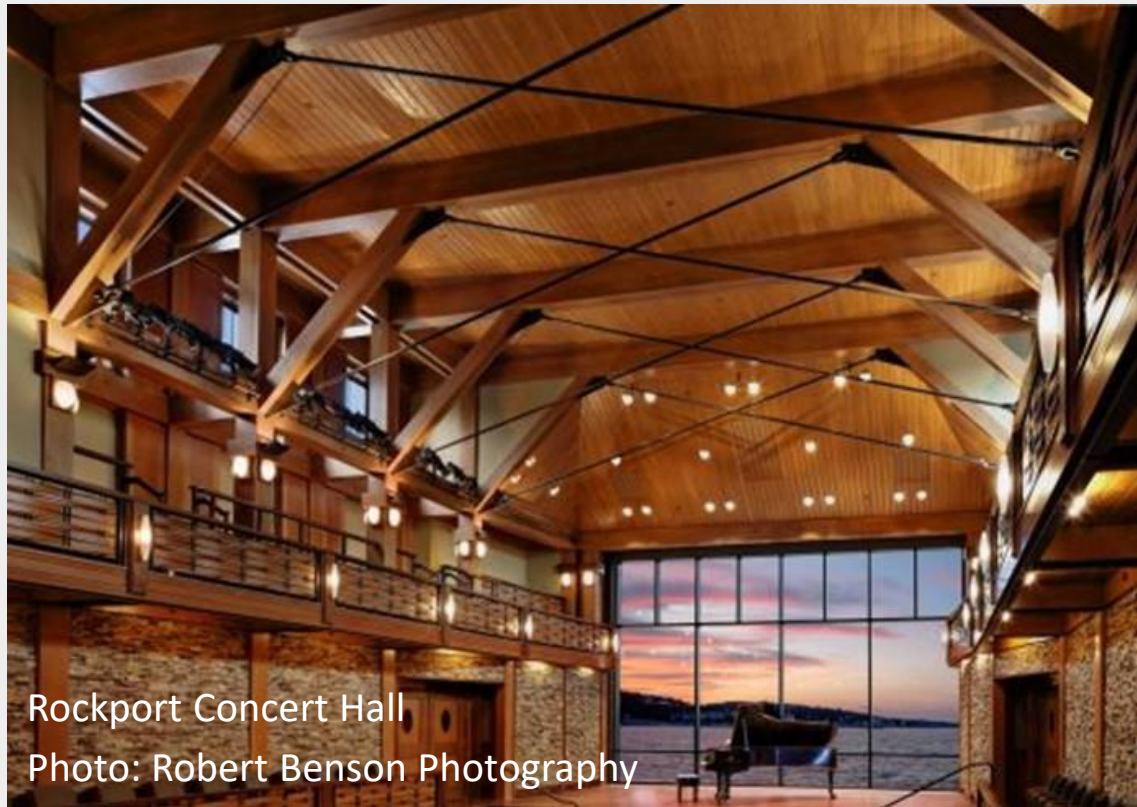


Room Acoustics

Total Space Noise Absorption:

To determine how much the sound in a space will decrease with the addition of sound absorbing materials, the total sabins of absorption for the space must be calculated.

To calculate this number, multiply the sound absorption coefficients of all the different types of materials in a room – at a particular frequency – by the area of coverage of each material.



Rockport Concert Hall

Photo: Robert Benson Photography

Acoustical Design

Types of noise to control: **Interior to interior**

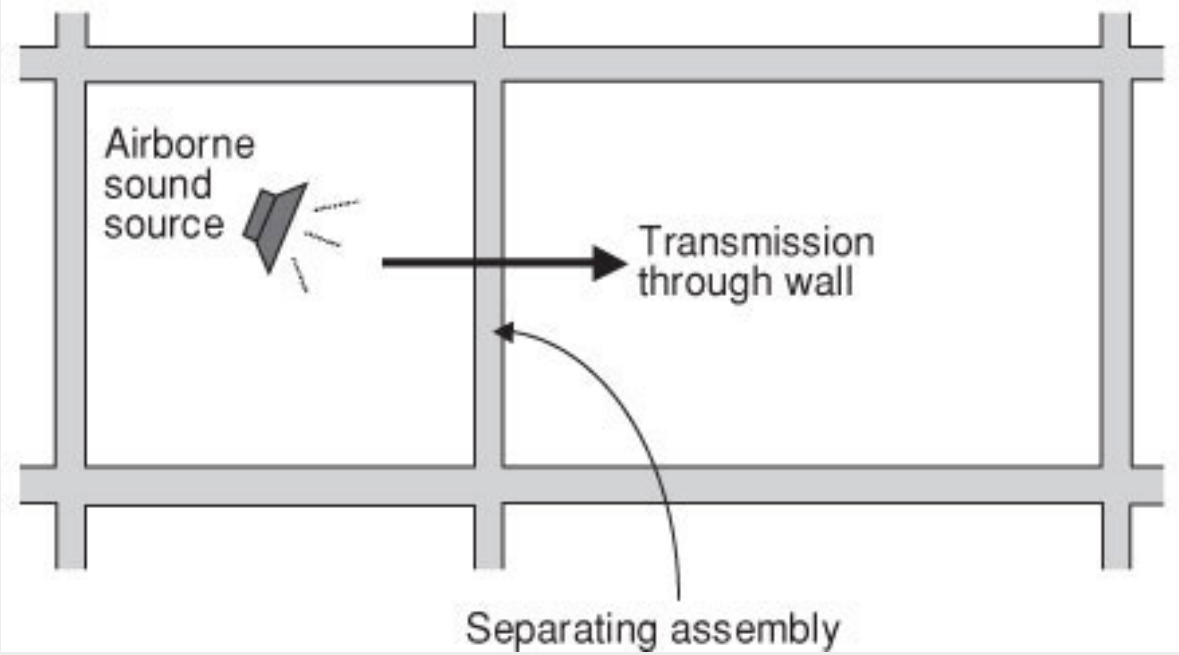
Photo: Eckert & Eckert Photography, GBD Architects

Acoustical Design

<u>Air-Borne Sound</u>: Sound Transmission Class (STC)

Measures how effectively an assembly isolates air-borne sound and reduces the level that passes from one side to the other

Applies to walls and floor/ceiling assemblies

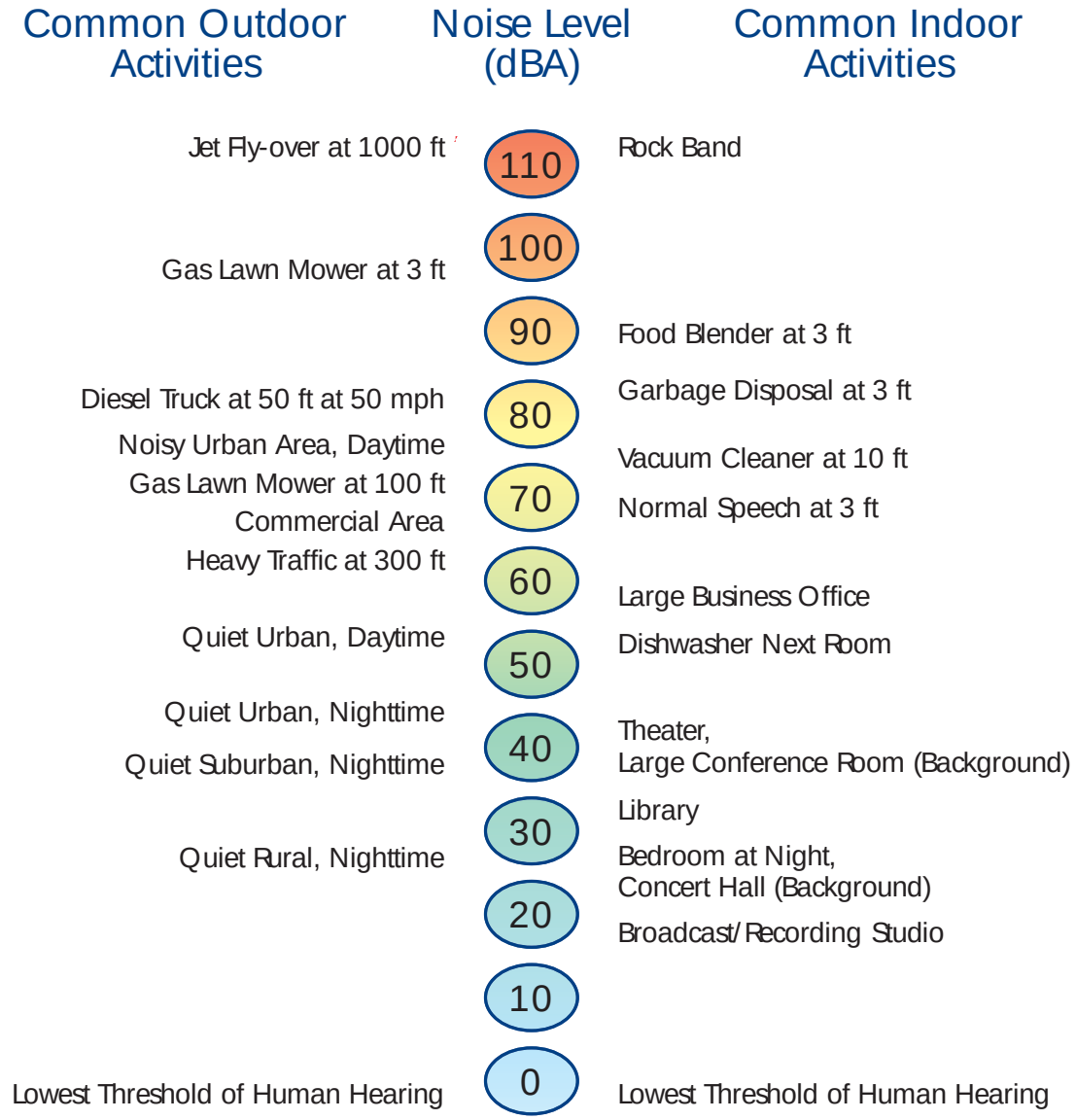


Acoustical Design

Changes in STC Rating	Changes in Apparent Loudness
+/- 1	Almost imperceptible
+/- 3	Just perceptible
+/- 5	Clearly noticeable
+/- 10	Twice (or half) as loud

Very roughly, an STC rating is the dB reduction from one side of an assembly to the other

LOUDNESS COMPARISON CHART (dBA)



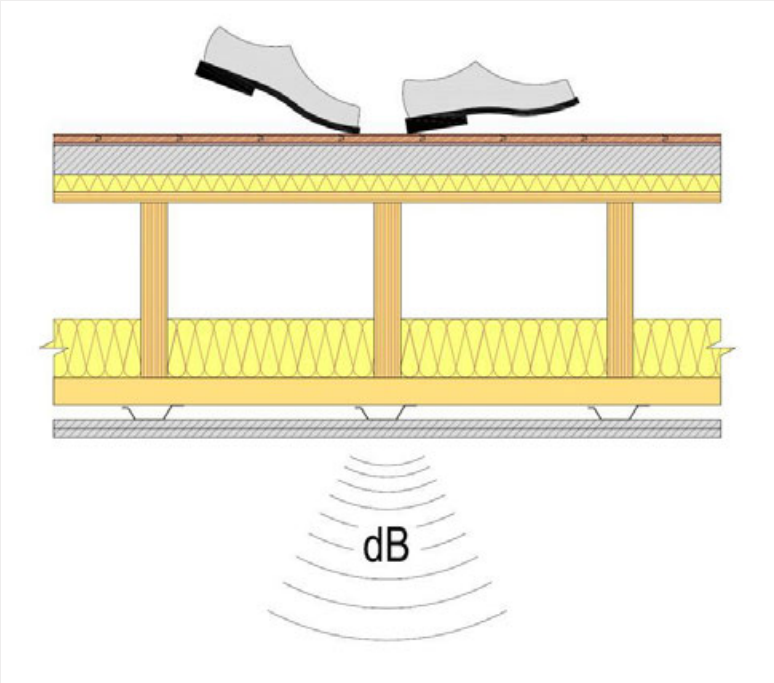
An increase of 3 dBA is barely perceptible to the human ear.

Acoustical Design

<u>Structure-borne sound</u>: Impact Insulation Class (IIC)

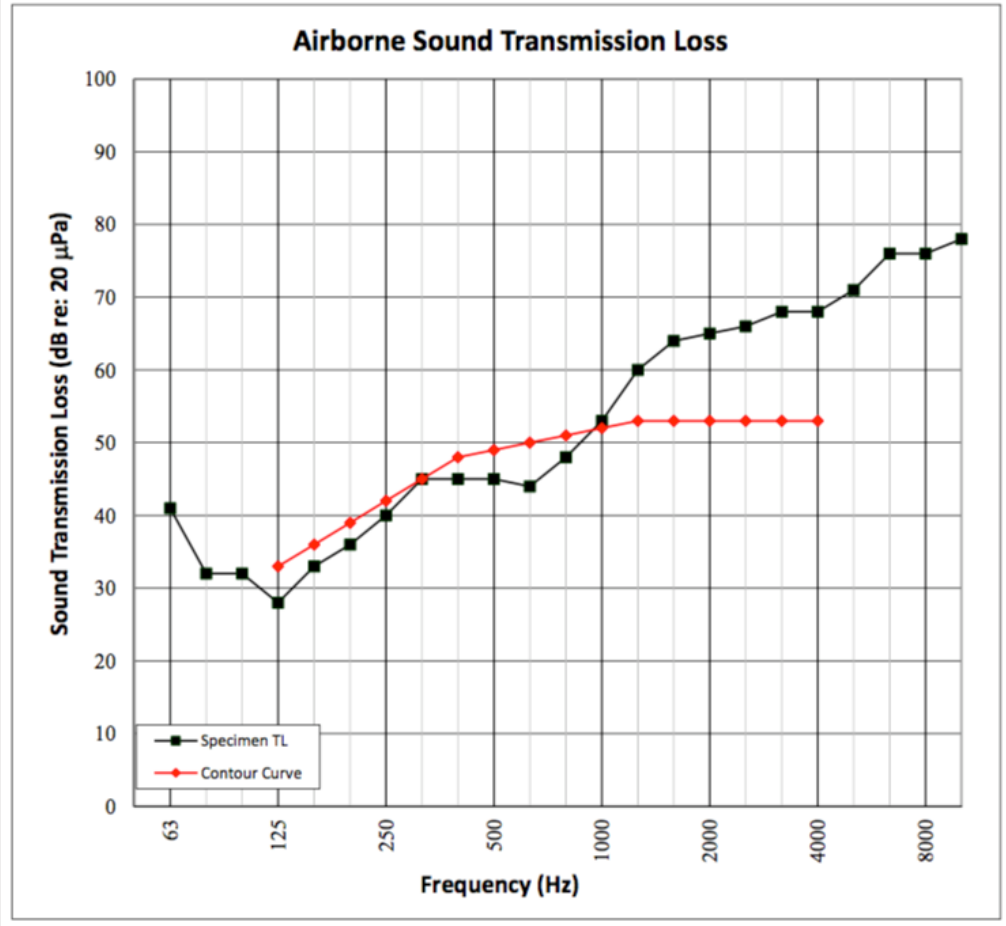
Evaluates how effectively an assembly blocks impact sound from passing through it

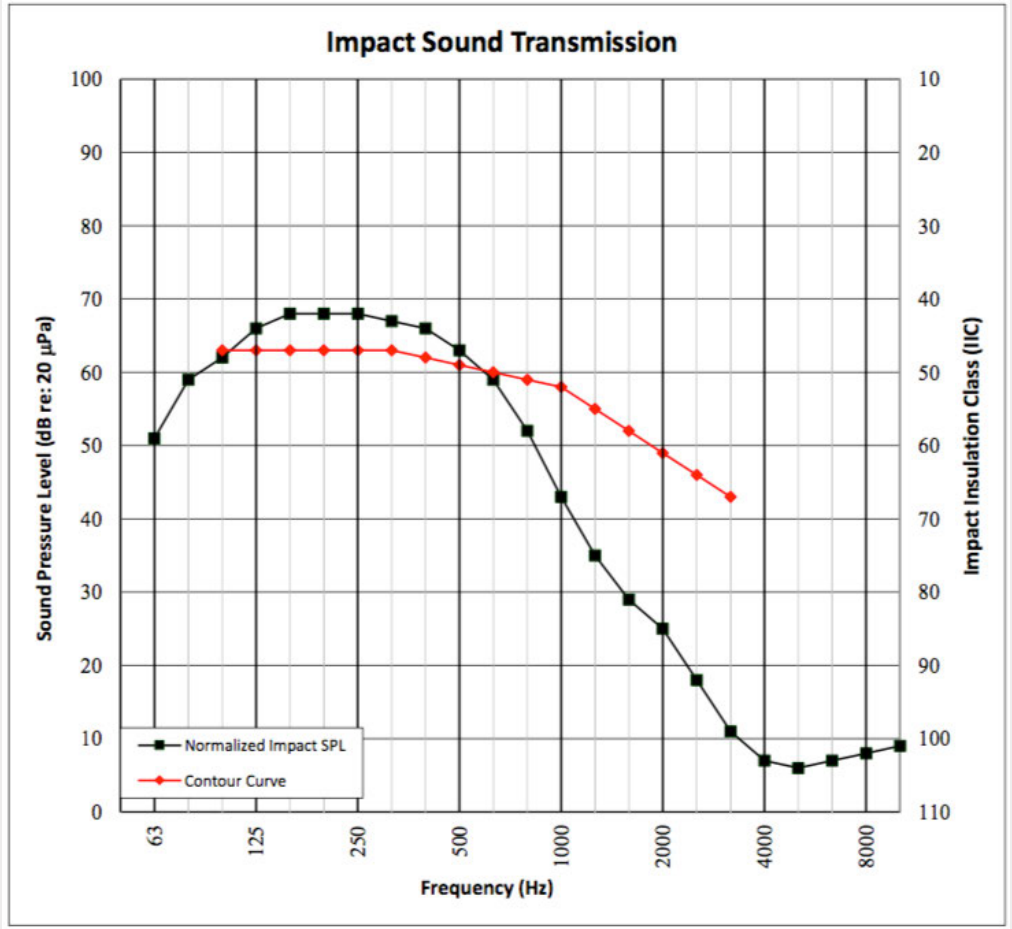
Only applies to floor/ceiling assemblies



Acoustical Design

STC and IIC Tests: Utilize 1/3 Octave Band Data measured at 16 frequencies from 125 to 4000 Hz





Acoustical Design

Low frequency (LIIC): “Thuds”

50-80 Hz, Determined primarily by the stiffness of the base structure

High frequency (HIIC): “Clicks”

400-3150 Hz, More relevant to acoustical underlayment and addresses typical human occupancy noises

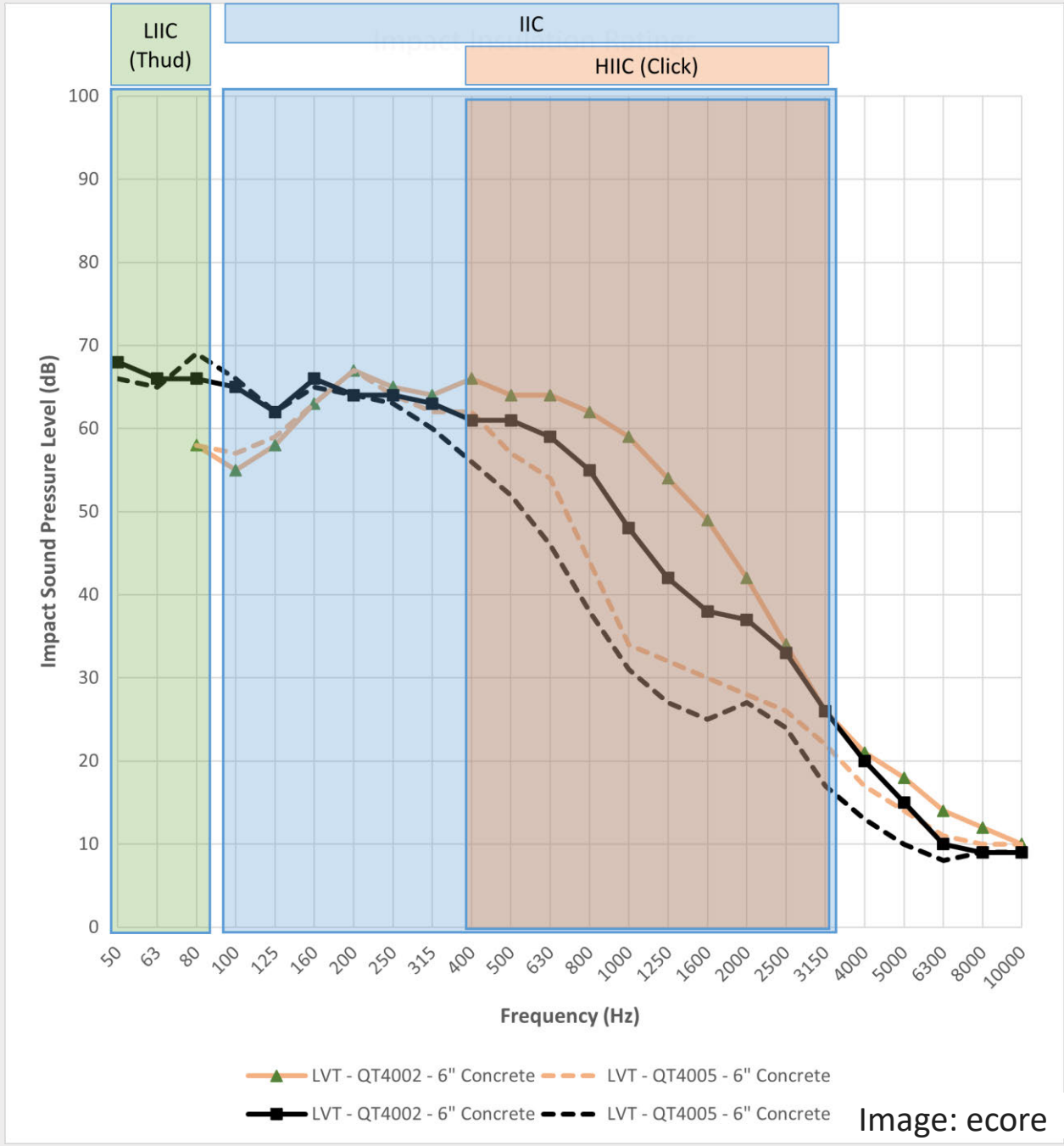


Image: ecore

Acoustical Design

ΔIIC (Delta IIC) – Improvement of IIC by the addition of an acoustical product to the base assembly

- May oversimplify underlayment performance
- Full assembly IIC test preferred

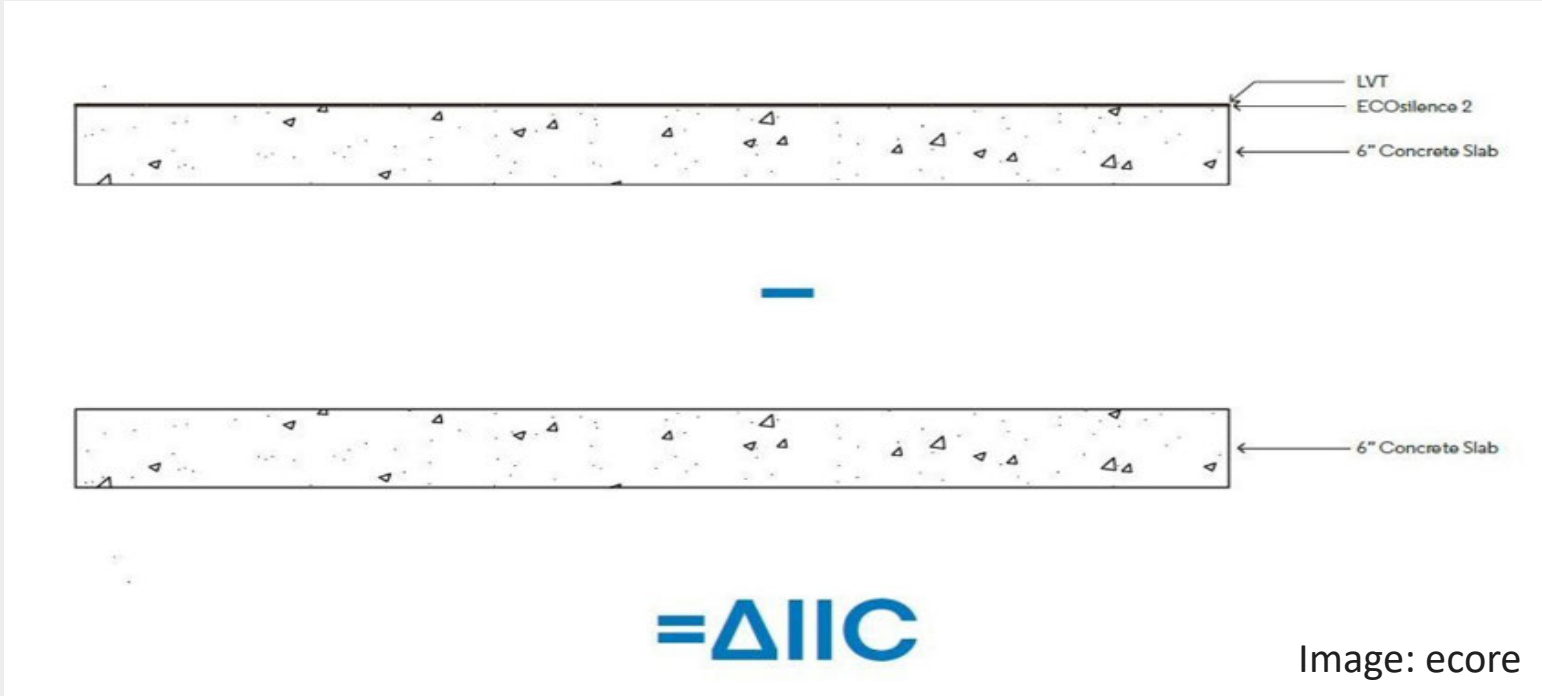


Image: ecore

Acoustical Design

On Site acoustic measurements:

- **FIIC** (old) – Field Impact Insulation Class
- **AIIC** (supercedes FIIC) – Apparent Impact Insulation

Ascent / New Land Enterprises / Korb + Associates Architects / Thorton Tomasetti / Photo VRX Media Group

Acoustical Criteria – IBC 1206

Code requirements only address residential occupancies:

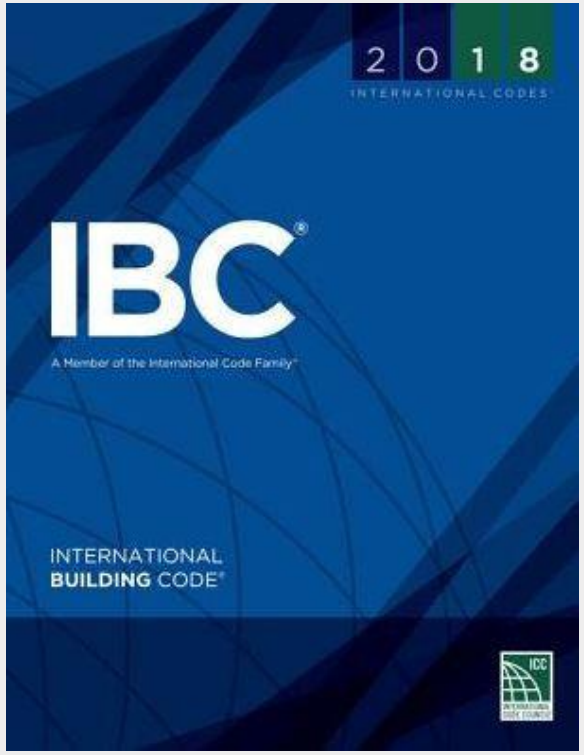
For unit to unit or unit to public or service areas:

Min. STC of 50 (45 if field tested) for:

- Walls, Partitions, and Floor/Ceiling Assemblies

Min. IIC of 50 (45 if field tested) for:

- Floor/Ceiling Assemblies



Acoustical Criteria

STC	What can be heard
25	Normal speech can be understood quite easily and distinctly through wall
30	Loud speech can be understood fairly well, normal speech heard but not understood
35	Loud speech audible but not intelligible
40	Onset of "privacy"
42	Loud speech audible as a murmur
45	Loud speech not audible; 90% of statistical population not annoyed
50	Very loud sounds such as musical instruments or a stereo can be faintly heard; 99% of population not annoyed.
60+	Superior soundproofing; most sounds inaudible


Beyond the 50

Acoustical Criteria

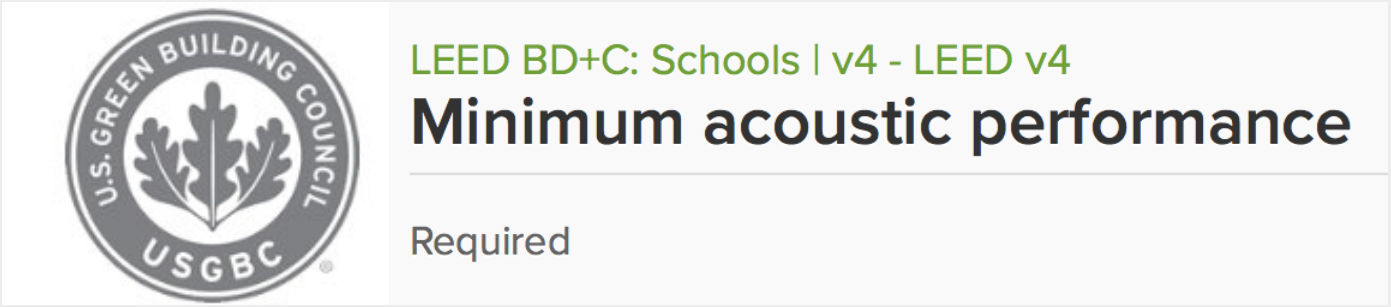
Acoustical Isolation Between Units – Airborne (STC) / Impact (IIC)

Class Designation	Airborne Sound Isolation (STC)	Floor Ceiling Impact Isolation (IIC)
Entry level	50	50
Market rate	55	55
Luxury	60	60

Acoustical Criteria

LEED has acoustics criteria for specific occupancies:

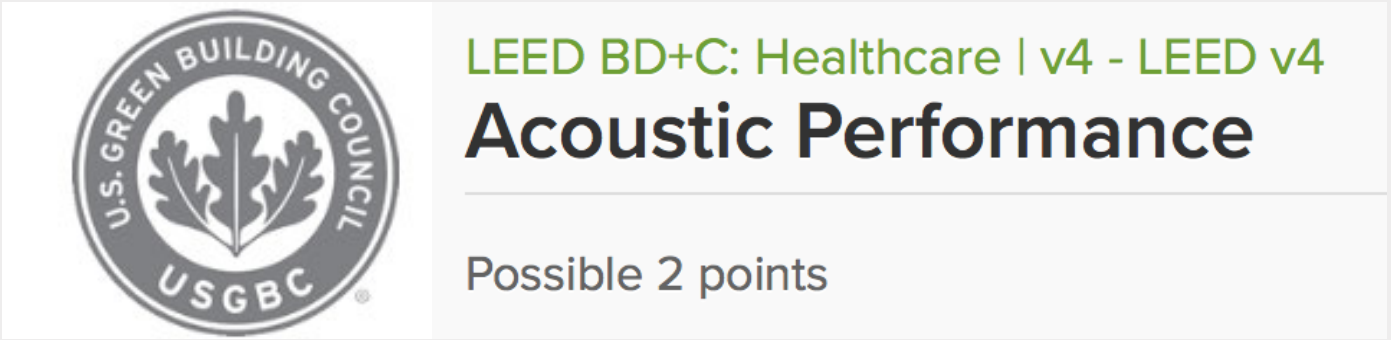
Schools:



Addresses items such as:

- HVAC background noise
- Exterior noise
- Reverberation time

Healthcare:



Addresses items such as:

- Speech privacy
- Background noise

Acoustical Detailing

Acoustically tested assemblies vs. calculated performance

COMMERCIAL

EXPECTED SYSTEM PERFORMANCE

SOUND CONTROL SYSTEM**	TOPICAL MAT	SOUND RATING
• 1" Maxxon Underlayment • Acousti-Mat 3/8 Premium	None	STC 53 / IIC 45

CODE MINIMUM

EXPECTED SYSTEM PERFORMANCE

SOUND CONTROL SYSTEM**	TOPICAL MAT	SOUND RATING
• 2" Maxxon Underlayment • Acousti-Mat 3/8 Premium	2 mm Foam Mat	STC 53 / IIC 50

ACCEPTABLE

EXPECTED SYSTEM PERFORMANCE

SOUND CONTROL SYSTEM**	TOPICAL MAT	SOUND RATING
• 2" Maxxon Underlayment • Acousti-Mat 3/4 Premium • Acousti-Mat SBR	Maxxon Acousti-Top	STC 57 / IIC 54

PREFERRED

EXPECTED SYSTEM PERFORMANCE

SOUND CONTROL SYSTEM**	TOPICAL MAT	SOUND RATING
• 1" Maxxon Underlayment • Acousti-Mat 1/8 • Insulated gypsum board ceiling	None	STC 60 / IIC 64

Source: Maxxon

Mass Timber Acoustics

Inventory of Tested Assemblies

Inventory of Acoustically Tested Mass Timber Assemblies

Following is a list of mass timber assemblies that have been acoustically tested as of June 14, 2023. Sources are noted at the end of this document. For free technical assistance on any questions related to the acoustical design of mass timber assemblies, or free technical assistance related to any aspect of the design, engineering or construction of a commercial or multi-family wood building in the U.S., email help@woodworks.org or contact the WoodWorks Regional Director nearest you:
http://www.woodworks.org/project-assistance

Contents:

https://www.woodworks.org/resources/inventory-of-acoustically-tested-mass-timber-assemblies/

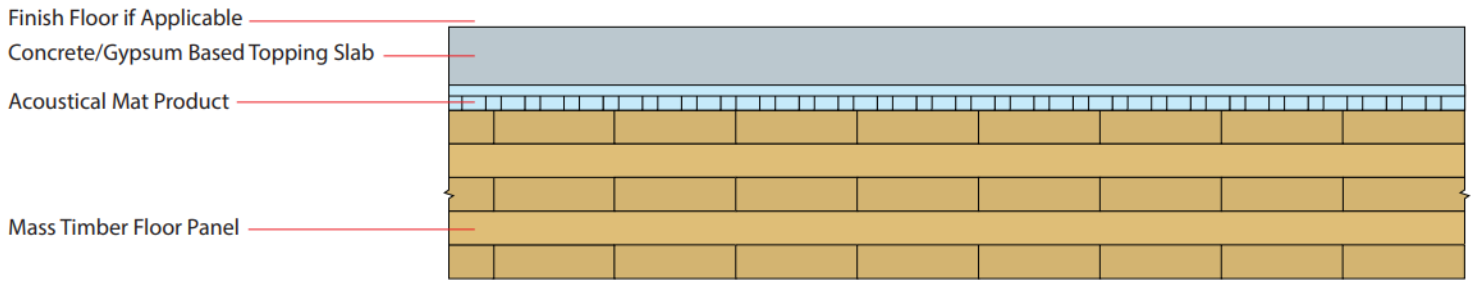
Acoustical Detailing

Can I acoustically rate individual components and then add them up for the system rating?

It depends…

Typical Mass Timber Floor Assembly

Section View



Examples of Acoustically-Tested Mass Timber Panels

Mass Timber Panel	Thickness	STC Rating	IIC Rating
5-ply CLT floor[5]	5.1875"	39	22
5-ply CLT floor[4]	6.875"	41	25
7-ply CLT floor[4]	9.65"	44	30
2x6 NLT floor + 1/2" plywood[2]	6" with 1/2" plywood	34	33

Description	STC	IIC
Carpet & Pad	0	20
3/4" Gypcrete®	7	1
Wood I-joist Floor	36	33
Resilient Channel	10	8
Total	***53***	***62***

Table 18.1.3. Example calculation.

Source: SBCA

Main difference between light frame wood floors and mass timber floors is that mass timber floors are usually left exposed on ceiling side.

All acoustical products applied on top of assembly

Photo: Structurlam

Mass Timber Acoustics

TABLE 1:

Examples of Acoustically-Tested Mass Timber Panels

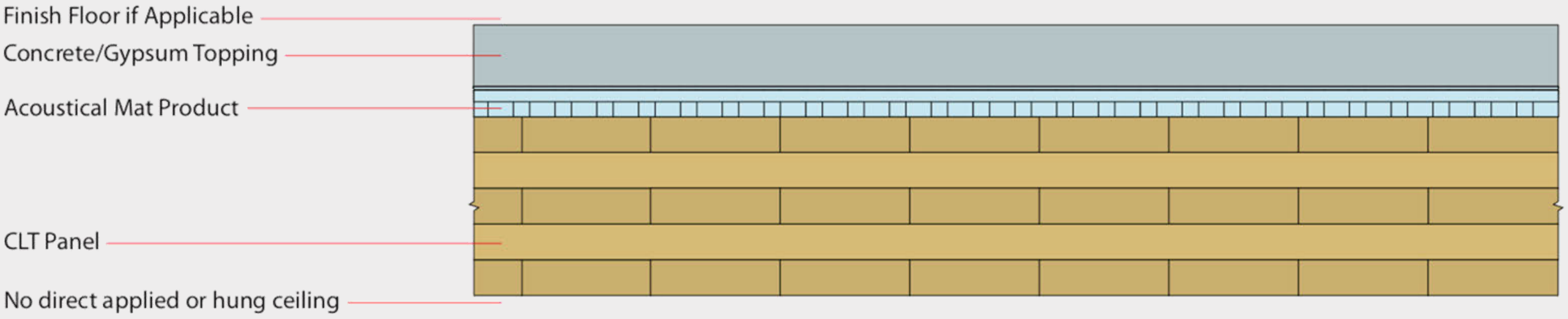
Mass Timber Panel	Thickness	STC Rating	IIC Rating
3-ply CLT wall[4]	3.07"	33	N/A
5-ply CLT wall[4]	6.875"	38	N/A
5-ply CLT floor[5]	5.1875"	39	22
5-ply CLT floor[4]	6.875"	41	25
7-ply CLT floor[4]	9.65"	44	30
2x4 NLT wall[6]	3-1/2" bare NLT 4-1/4" with 3/4" plywood	24 bare NLT 29 with 3/4" plywood	N/A
2x6 NLT wall[6]	5-1/2" bare NLT 6-1/4" with 3/4" plywood	22 bare NLT 31 with 3/4" plywood	N/A
2x6 NLT floor + 1/2" plywood[2]	6" with 1/2" plywood	34	33

Source: Inventory of Acoustically-Tested Mass Timber Assemblies, WoodWorks[7]

Acoustical Detailing

There are three main ways to improve an assembly's acoustical performance:

1. Add mass
2. Add noise barriers
3. Add decouplers



Acoustical Detailing

<u>Concrete Slab:</u>
6” Thick
80 PSF
STC 53

<u>CLT Slab:</u>
6-7/8” Thick
18 PSF
STC 41

Acoustical Detailing

Common mass timber floor assembly:

- Finish floor (if applicable)
- Underlayment (if finish floor)
- 1.5” to 3” thick concrete/gypcrete topping
- Acoustical mat
- WSP (if applicable)
- Mass timber floor panels

Image: AcoustiTECH

Acoustical Detailing

What is Flanking?

Sound can bypass or “flank” sound protections, such as the wall or floor assemblies, by travelling through, around, or over/under the primary partitions.

Image: iKoustic
www.ikoustic.co.uk

Acoustical Detailing

Flanking control:

- Eliminate gaps
- Consider ductwork
- Mass timber panel isolation

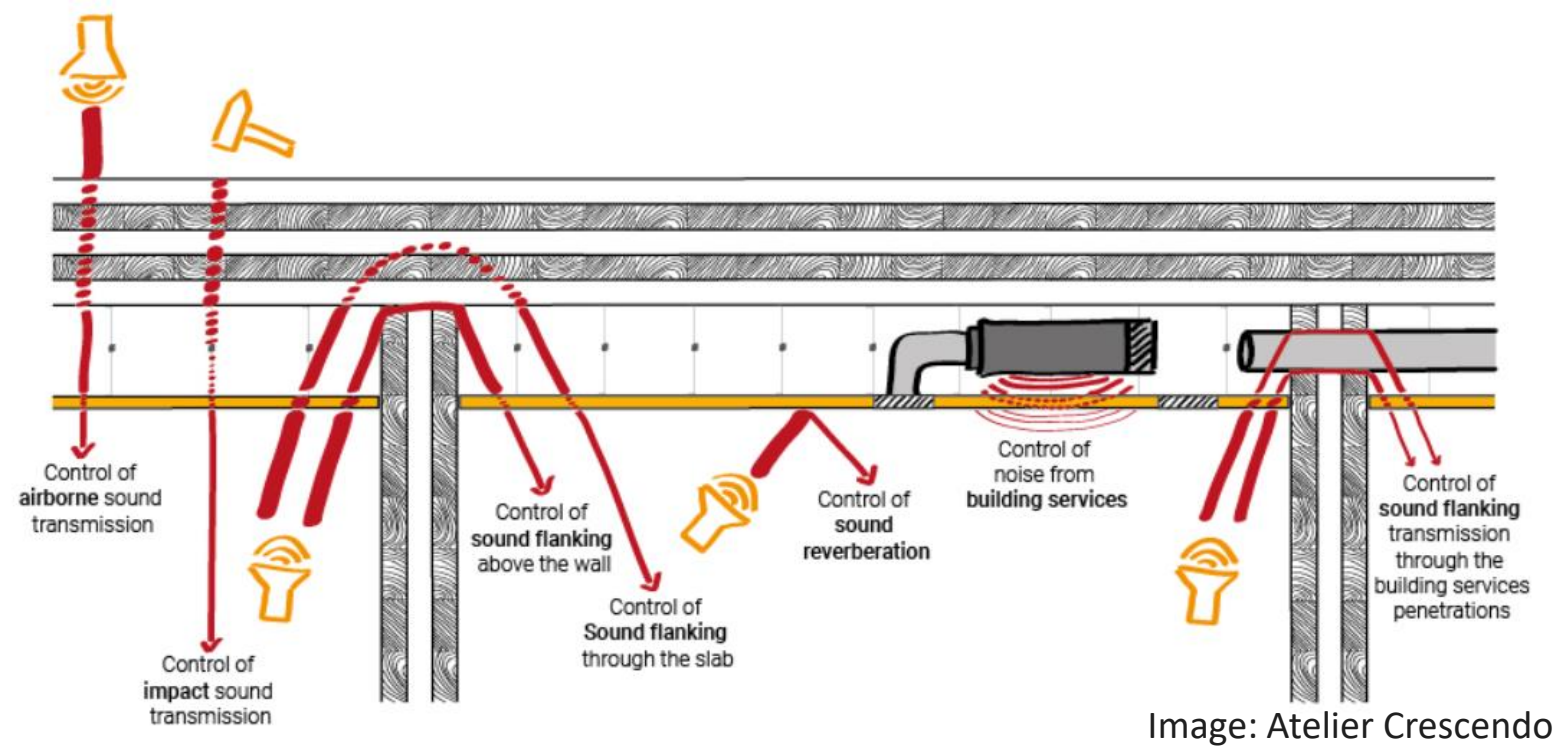
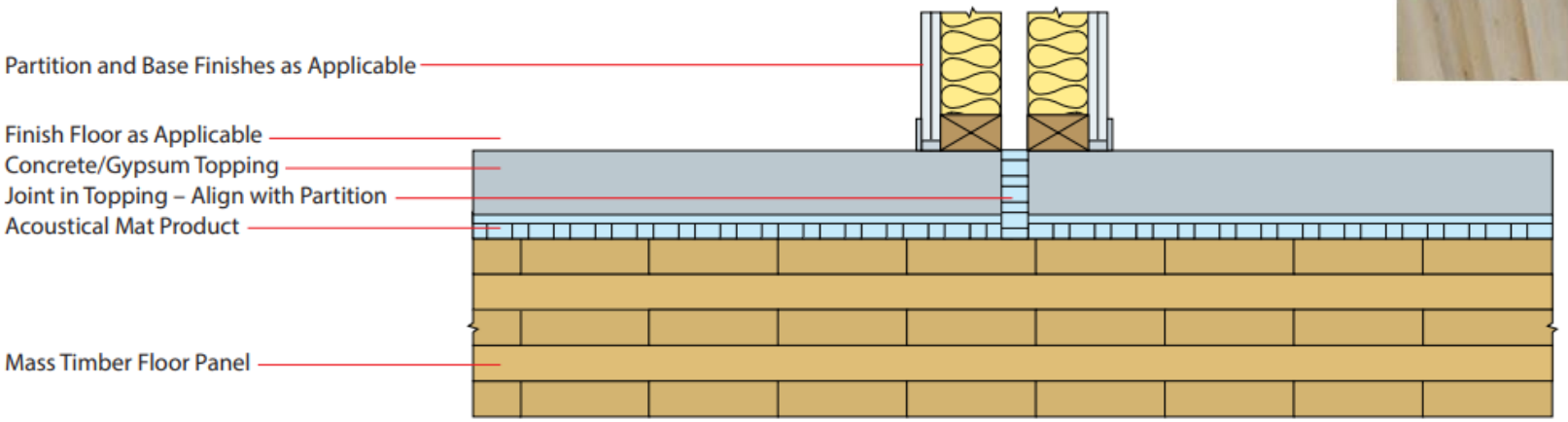


Image: Atelier Crescendo

Acoustical Detailing: Panel Isolation

Photo: Maxxon Corporation

Image: Rothoblaas



QUESTIONS?

This concludes The American Institute of Architects Continuing Education Systems Course

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