Simplified and Sustainable Acoustic Solutions for High-Performance Mass Timber Buildings

AcoustiTECH

acousti-tech.com

Agenda

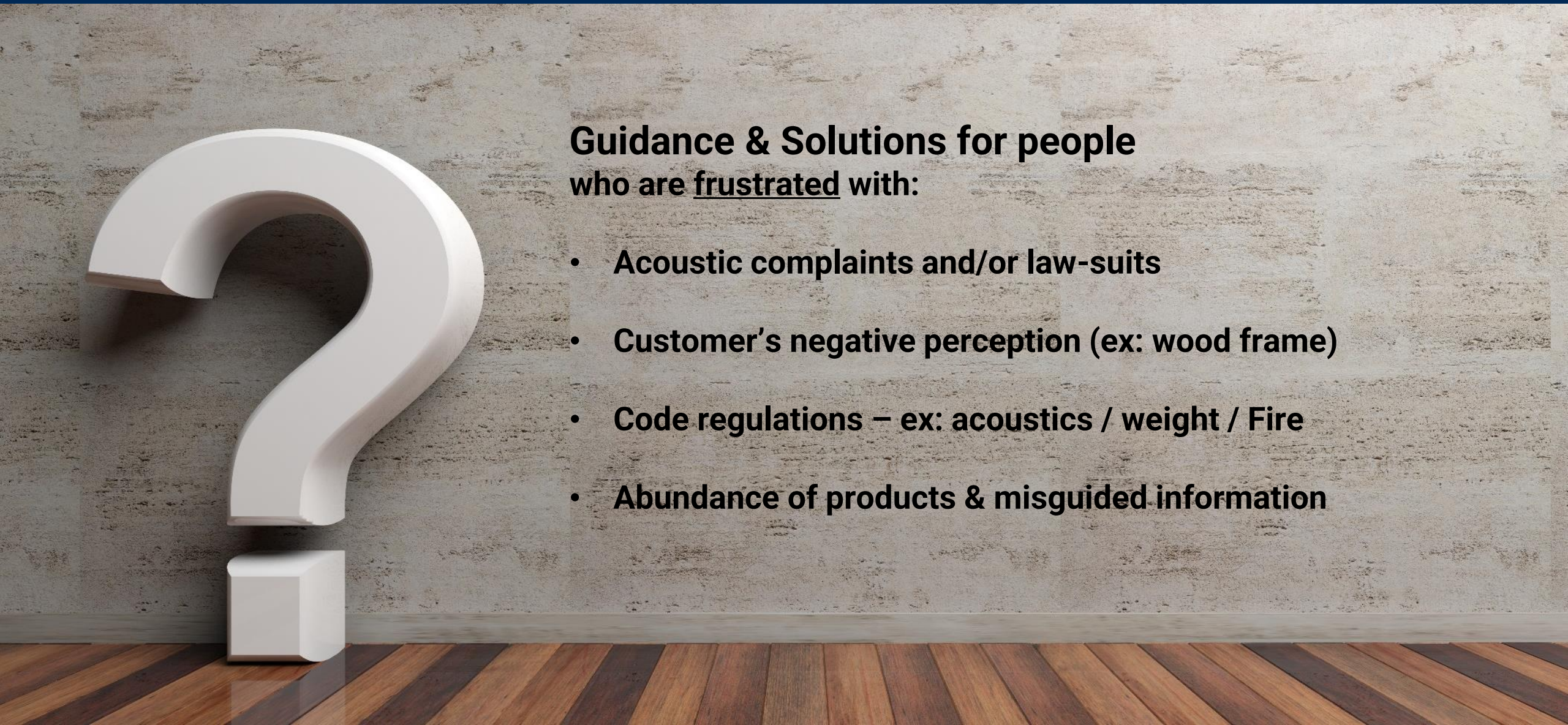
- Introduction and Introductions
- Code Requirements / Expectations
- A good approach to designing Mass Timber buildings
- Flanking mitigation
- Latest solutions for mass timber with exposed ceiling
- Wet versus dry solutions for Mass Timber
- Sustainability
- What’s next ?

AcoustiTECH

Andre Rioux

Co-Owner
Ambassador

Mission : Acoustic comfort



Guidance & Solutions for people
who are frustrated with:

- **Acoustic complaints and/or law-suits**
- **Customer’s negative perception (ex: wood frame)**
- **Code regulations – ex: acoustics / weight / Fire**
- **Abundance of products & misguided information**

- Innovative polymer-based solutions
- Acoustic clips
- Acoustic membranes
- Drainage solutions

SOPREMA

Sibe ACOUSTIQUE

- Expertise
- Off-site support
- On-site support
- Testing
- Training
- R&D

AcoustiTECH
PERFORMANCE CREDIBILITY EXPERTISE

- Complete support
- Recommendations
- Innovative textile solutions
- Data / reports
- On-site assistance
- Laboratory
- R&D
- Documentation

fermacell
By DCC

- Innovative dry elements made of recycled material
- Light-weight solutions
- Versatile
- Ease of installation

Sibe ACOUSTIQUE

- Expertise
- Off-site support
- On-site support
- Testing
- Training
- R&D

David Dompierre, ing.
Senior Consultant

David Gonzalez

LEED Green Associate

DCC solutions

LEED GREEN ASSOCIATE

- Ambassador of acoustic solutions, exterior cladding and fire protection
- Supporter of healthy, ecological and low carbon footprint building materials.

Mission

“Dare build differently”

DARE BUILD DIFFERENTLY

DCC solutions

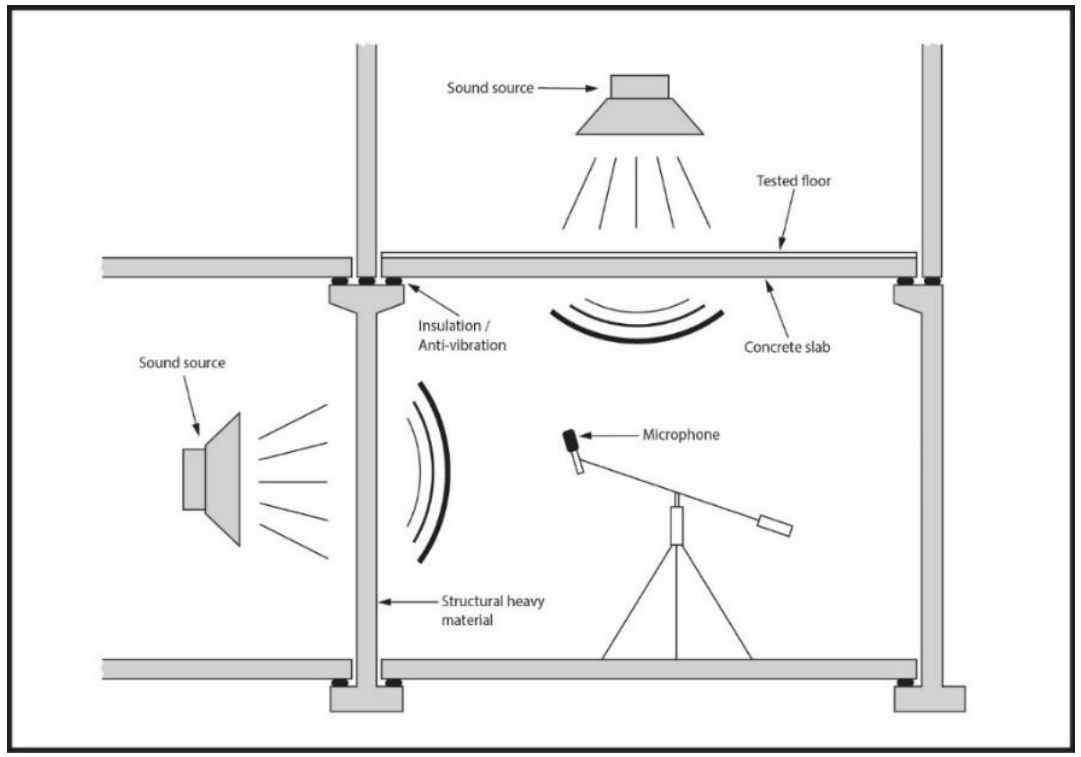
Now let’s set the table…

- Wood buildings offer great advantages
- Great results can be achieved when paying attention to details
- Unfortunately, acoustics is too often neglected = Frustrations

Sound insulation
is now a must!

Code requirements & expectations

AIRBORNE NOISES = REQUIREMENTS

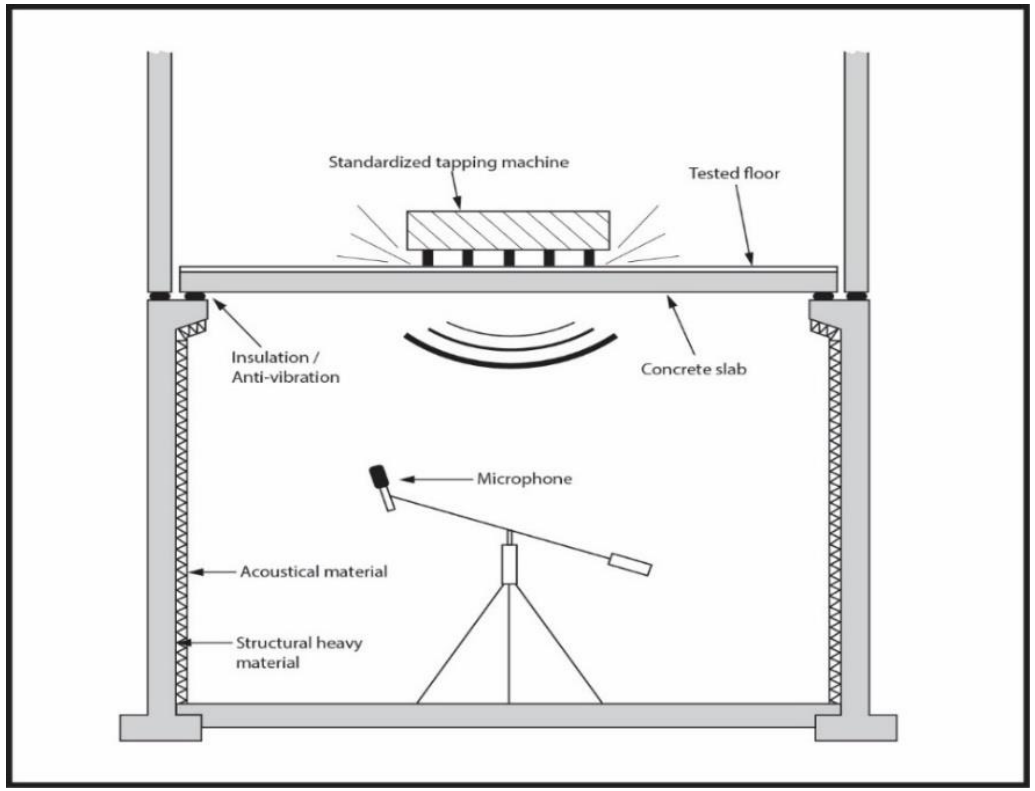


Canada:
Minimum STC required = 50
Minimum ASTC required = 47
Recommended minimum STC = 55

USA:
Minimum STC required = 50
Minimum ASTC = 45

Code requirements & expectations

IMPACT NOISES = RECOMMENDATIONS

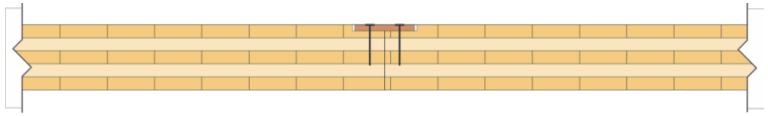


Canada:
Minimum IIC required = N/A
Minimum AIIC required = N/A
Recommended min. IIC = 55

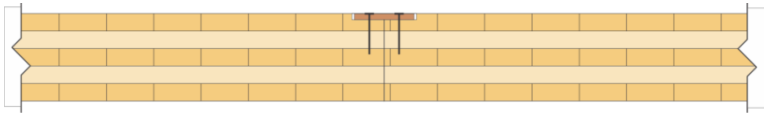
USA:
Minimum IIC required = 50
Minimum AIIC = 45

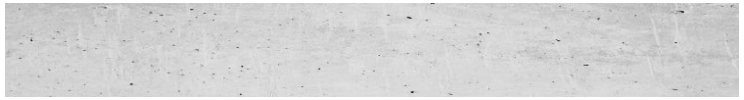
A good approach to designing mass timber

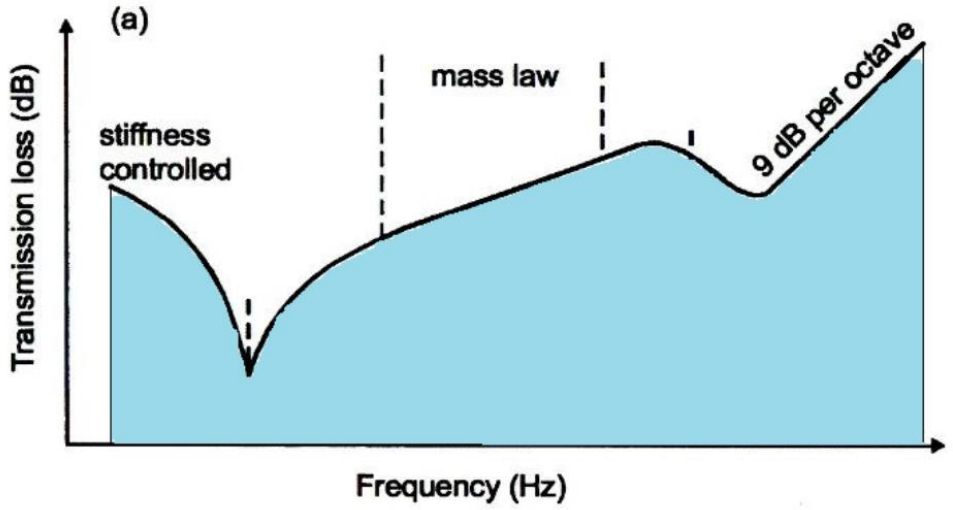
Thickness/surface weight dependency

130mm  13,7 PSF – STC 39 – IIC 23

150mm  16 PSF – STC 41 – IIC 24

175mm  18,6 PSF – STC 42 – IIC 26

175mm  86,1 PSF – STC 56 – IIC 30



Adding mass (approx. 20 PSF) over a performing underlayment can increase the STC by 14 and IIC by 17 to 22 points in average.

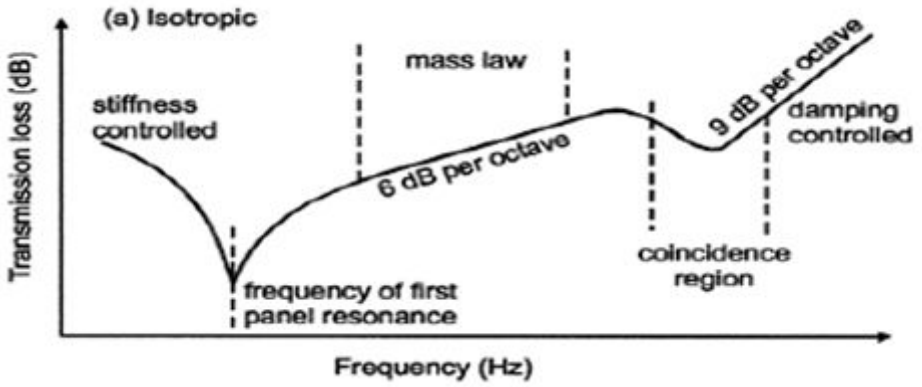
The flooring and its underlayment may have minimal impact on the resulting performance.

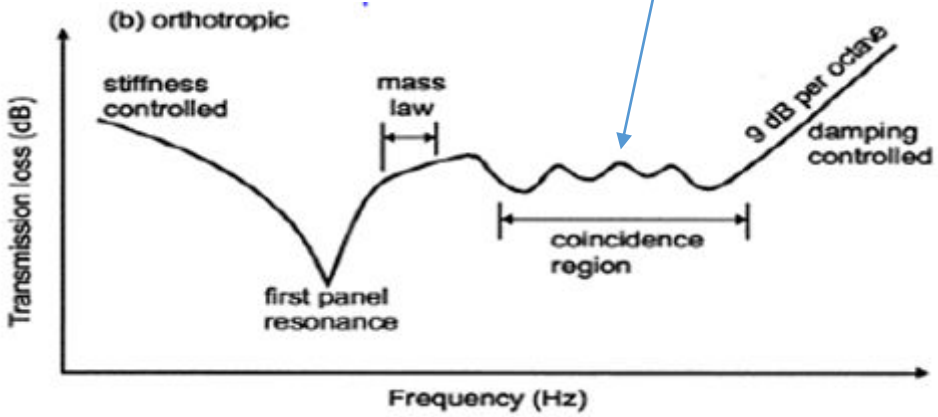
A good approach to designing mass timber

Stiffness/construction dependency

"At low frequencies the partition tends to move as a membrane exhibiting bending motions. The more resistance there is to this bending motion, that is, the greater the panel stiffness, the higher will be the low frequency transmission loss obtained" (Noise Control in Building services, Sound Research Laboratories Ltd. Pergamon press. p107-108)

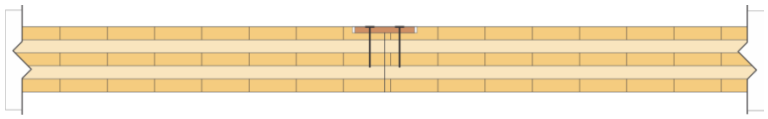
Coincidence region in CLT can be large and can be happening in areas relevant to building acoustics. The important width of the area, compared to the graph on the left is caused by the intersecting layers of timber (orthotropic panel).

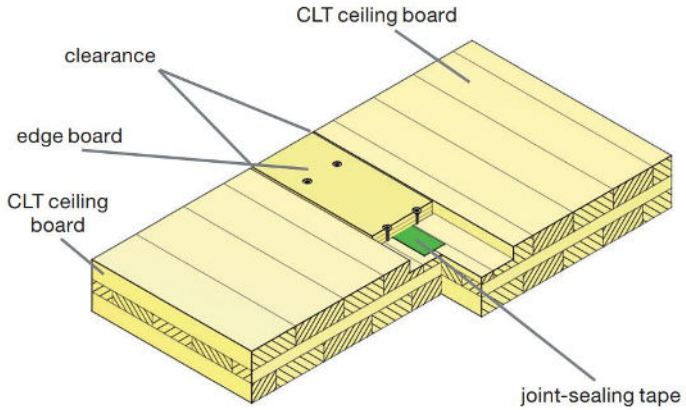


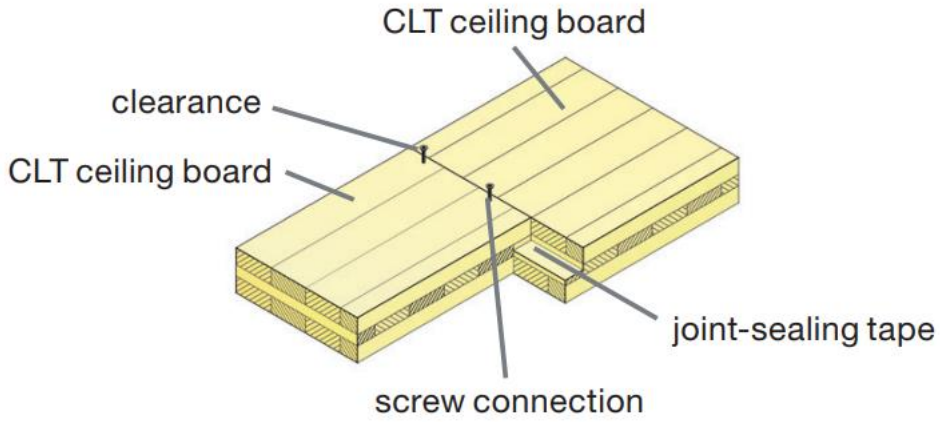


A good approach to designing mass timber

Permeability dependency

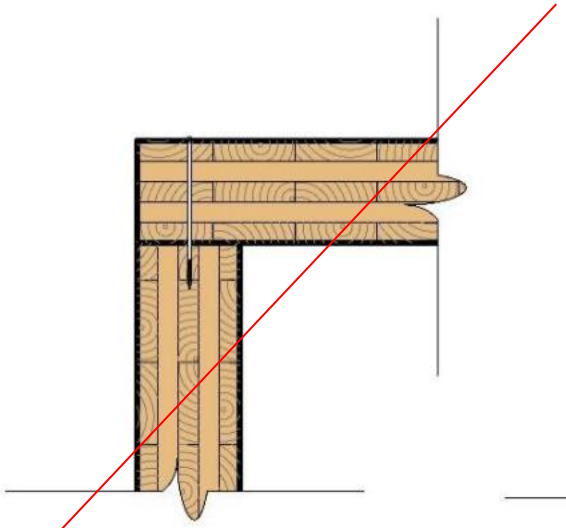




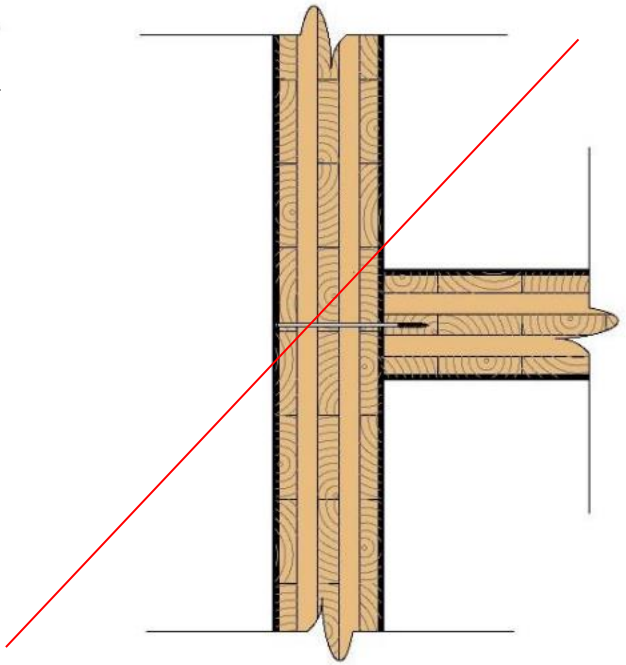


A good approach to designing mass timber

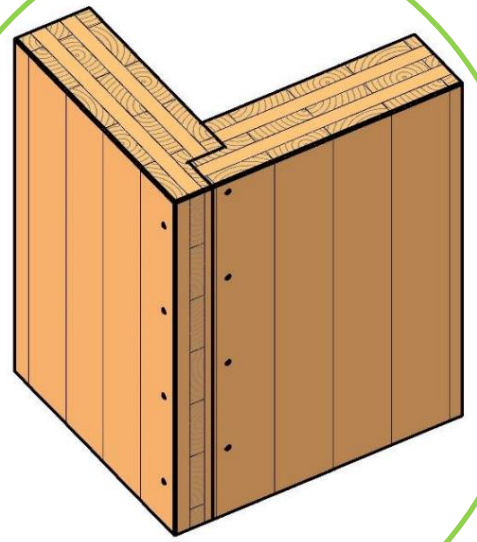
Permeability dependency



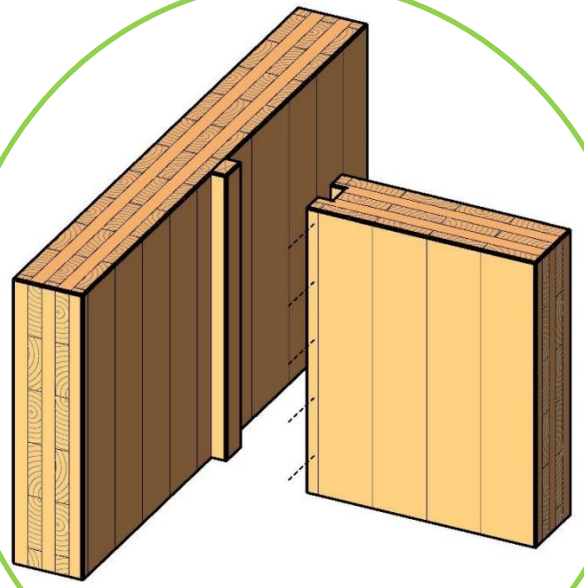
Butt corner joint



Butt wall intersection



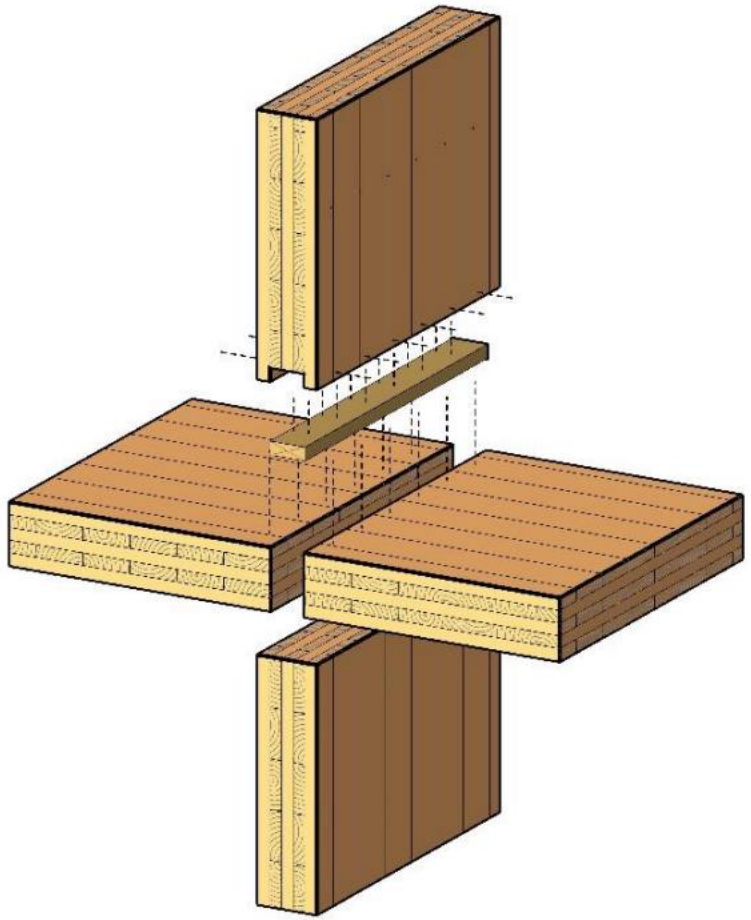
Rabbeted corner joint

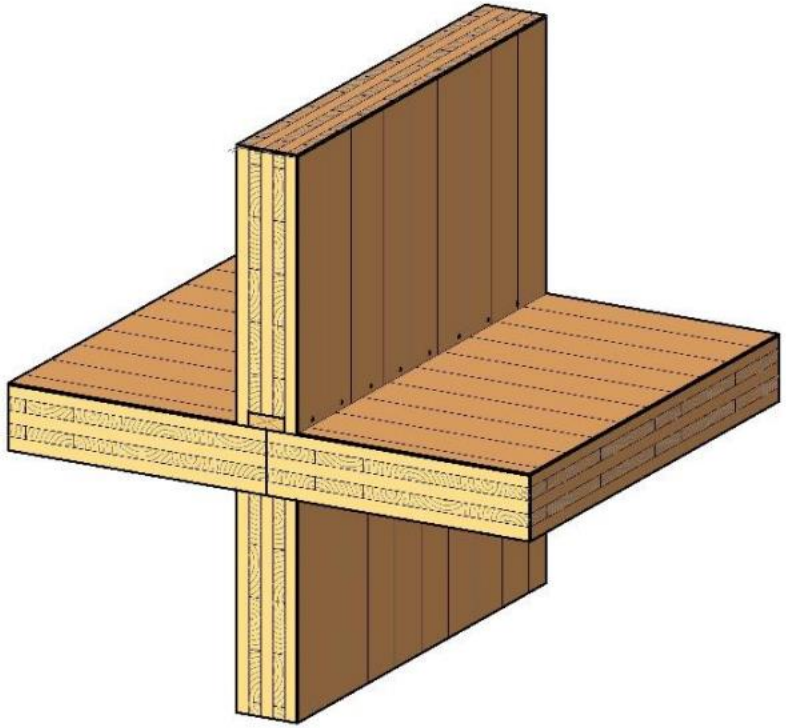


Cleated wall intersection

A good approach to designing mass timber

Permeability dependency

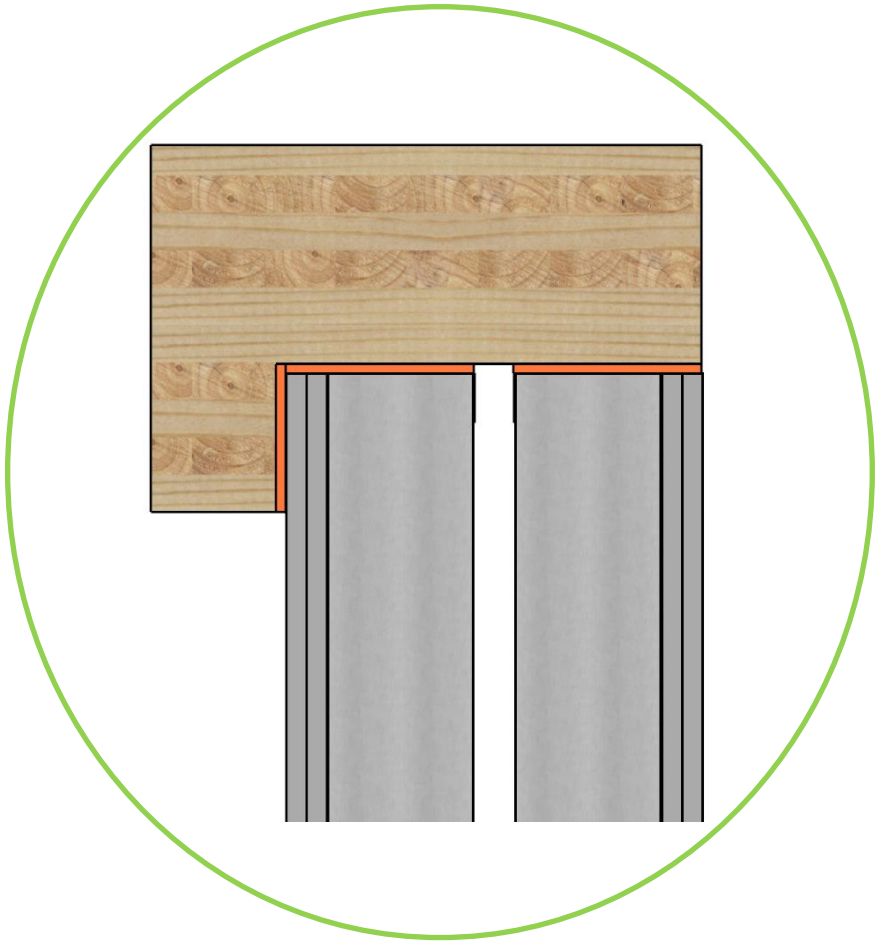


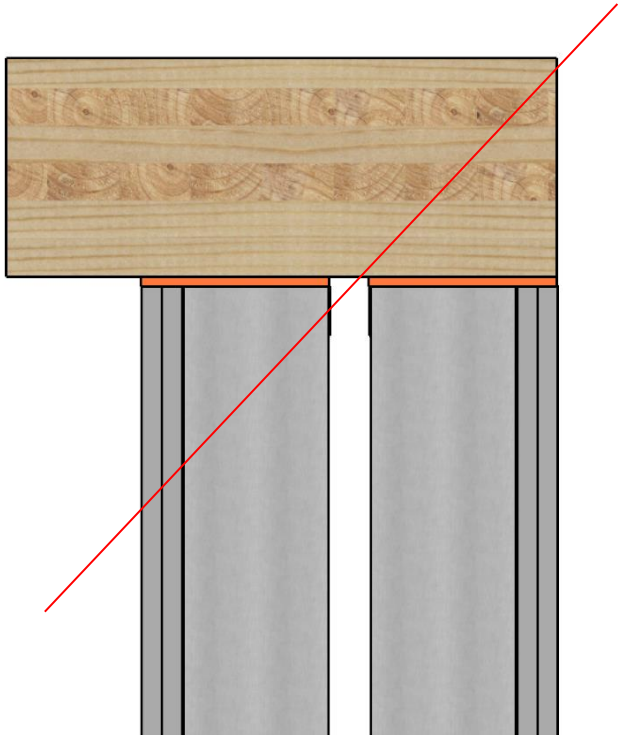


Cleated platform frame joint

A good approach to designing mass timber

Permeability dependency

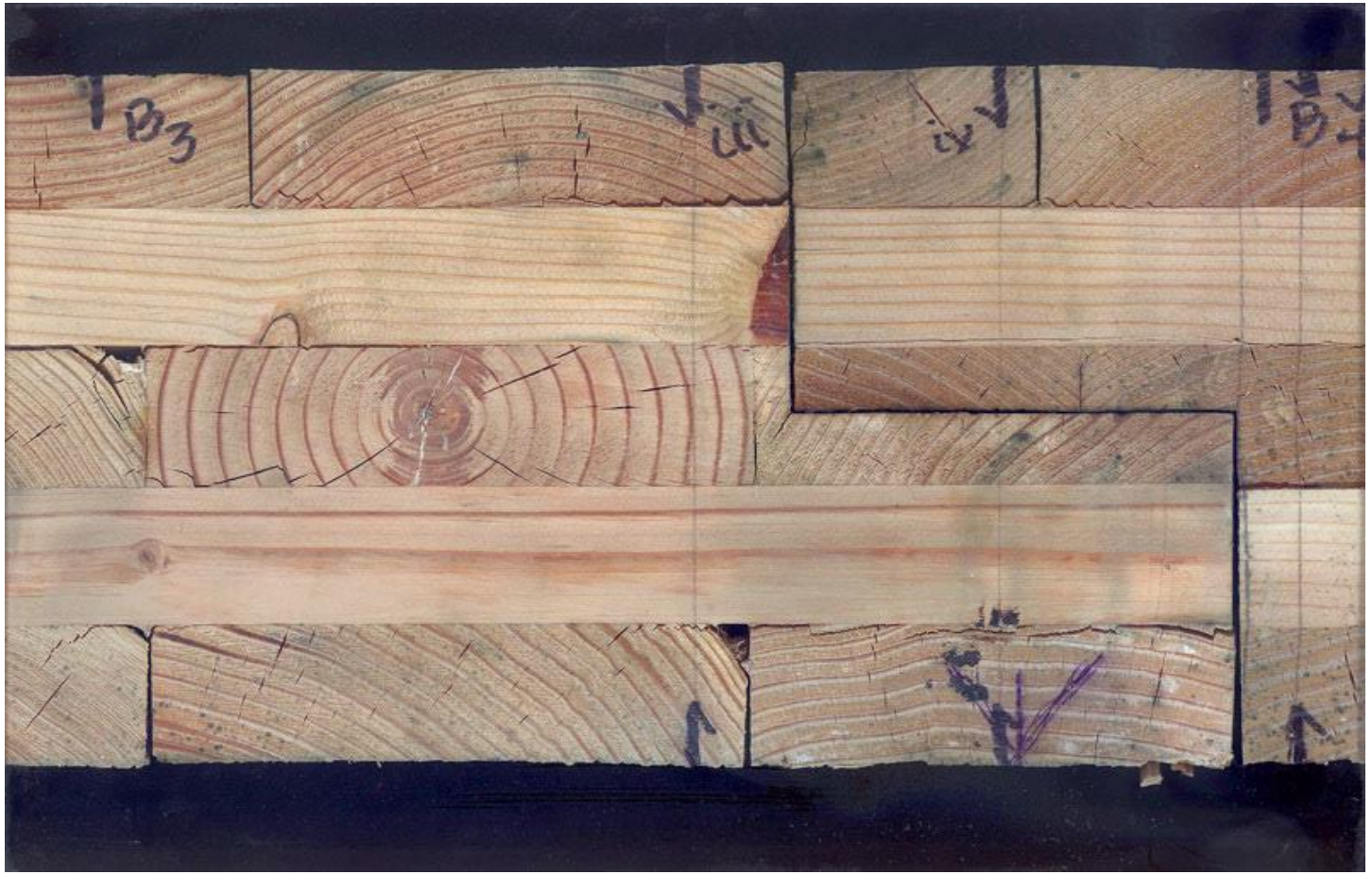




Insertions are good

A good approach to designing mass timber

Permeability dependency



Moisture issues

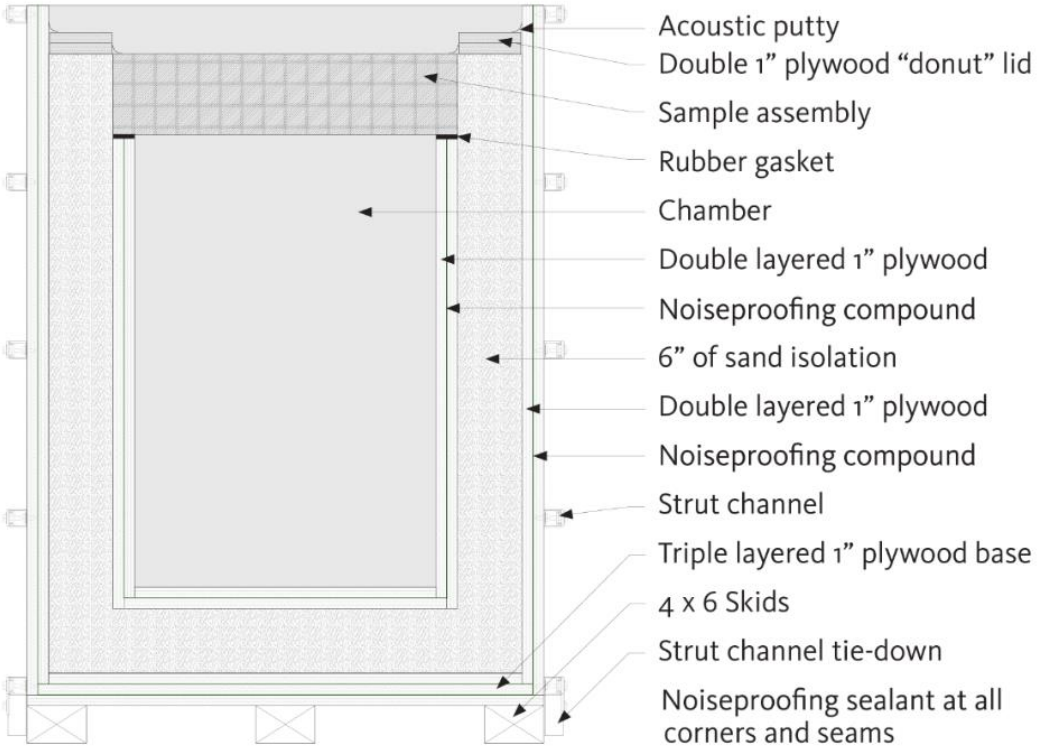
A good approach to designing mass timber

Choosing the right connectors

Vibration reduction index (K_{ij})

A good approach to designing mass timber

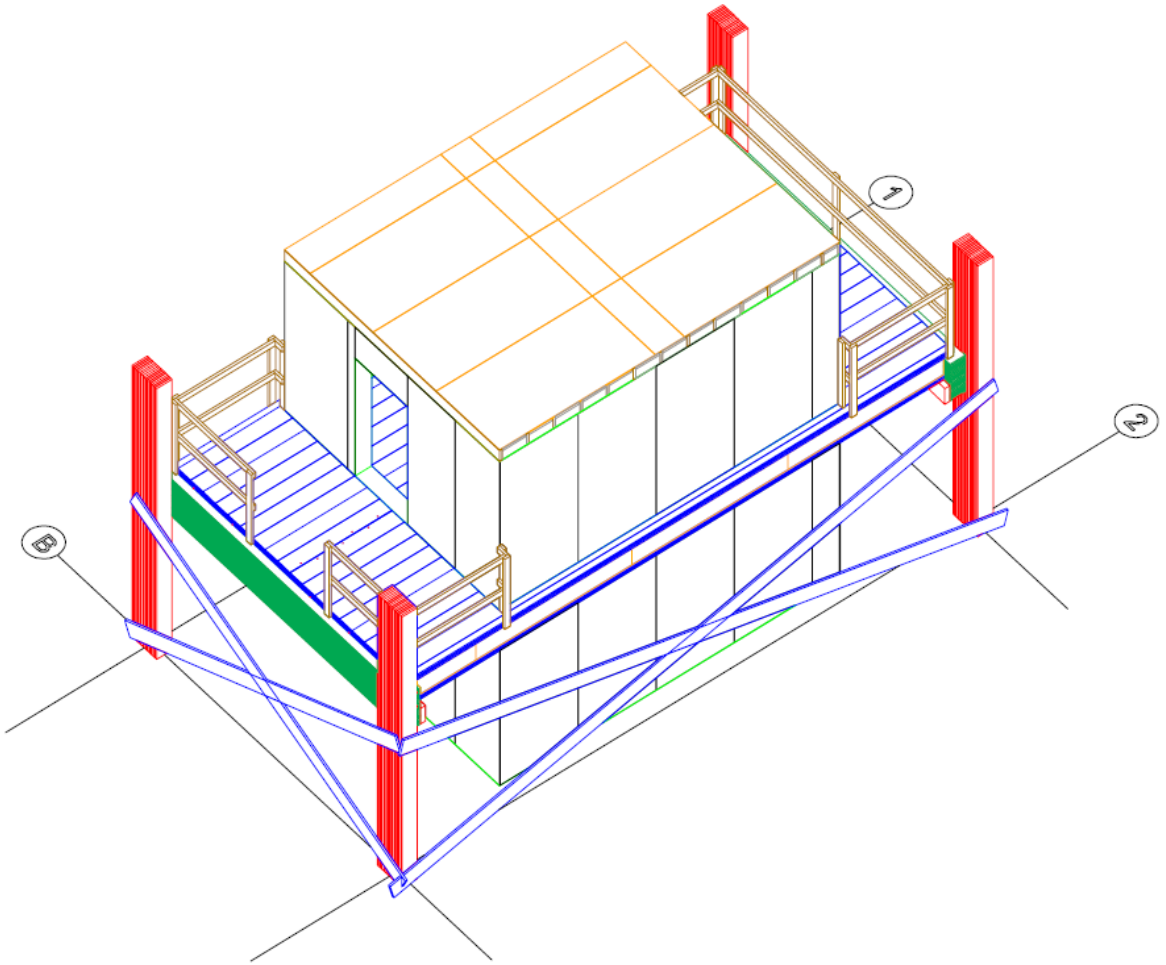
Let manufacturers participate in testing



University of Oregon Microacoustic Chamber

A good approach to designing mass timber

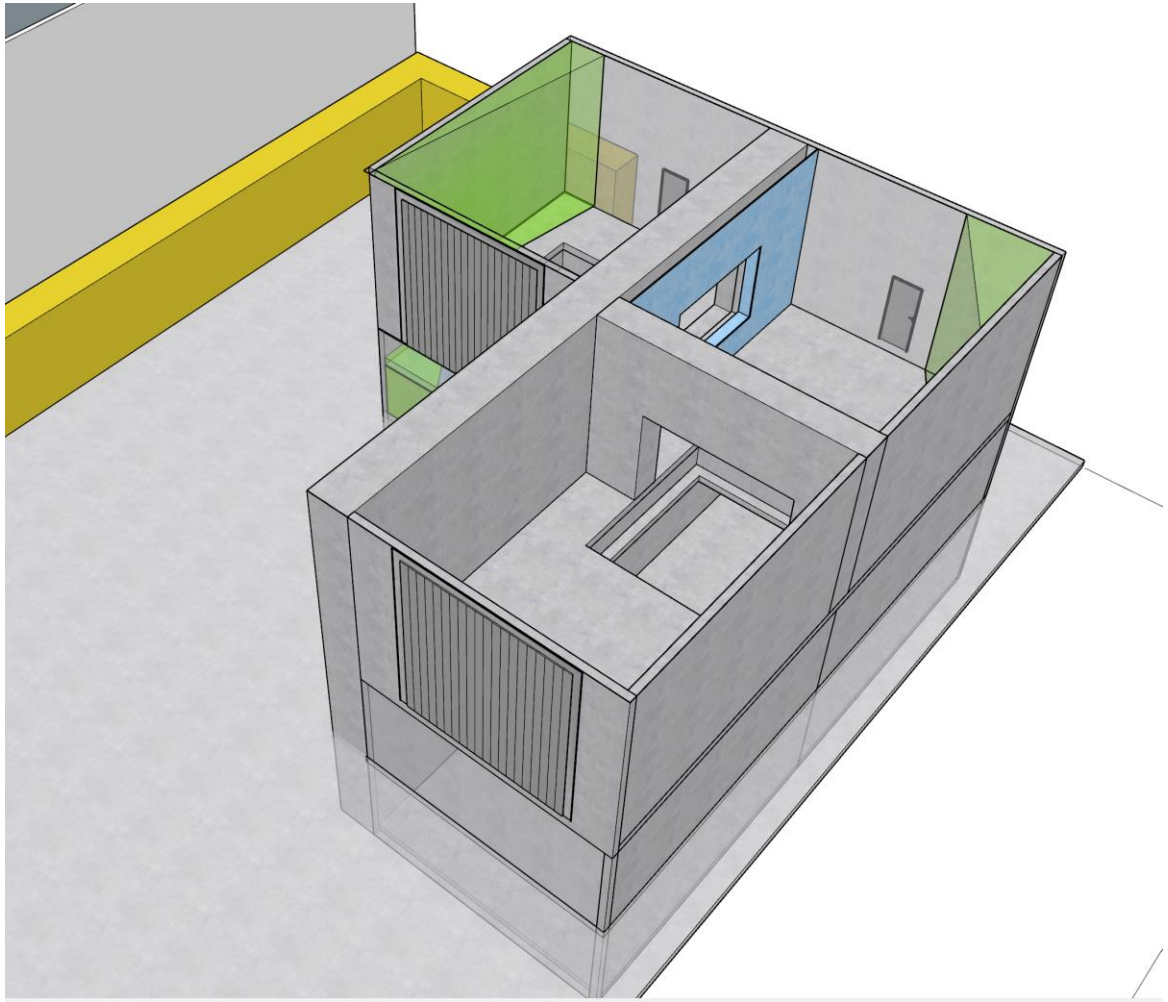
Let manufacturers participate in testing



Testing bench – Element5, Ontario

A good approach to designing mass timber

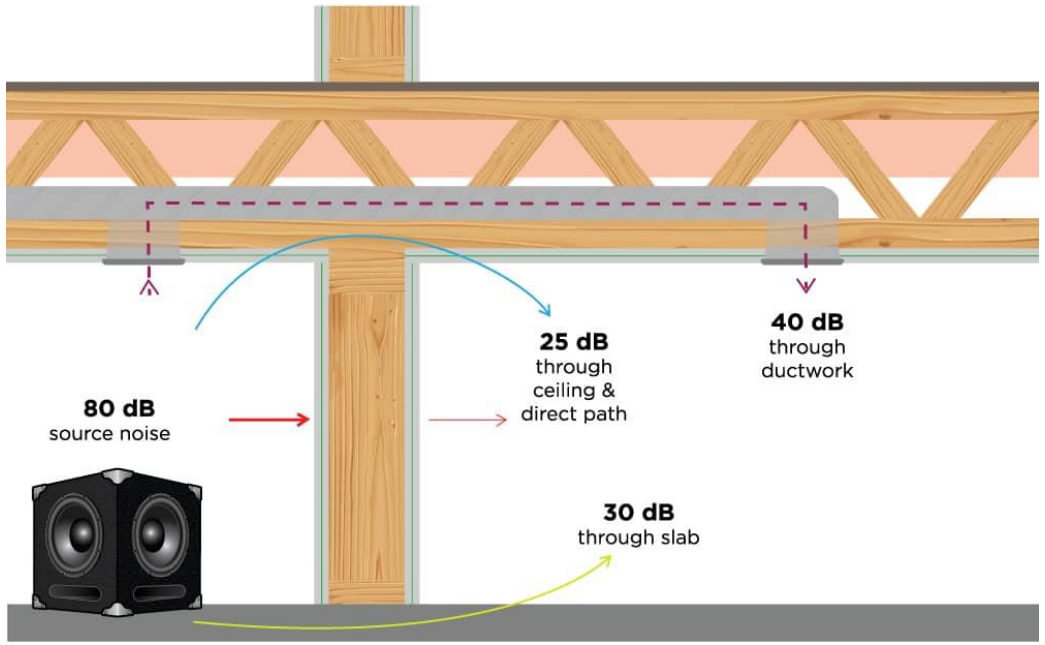
Let manufacturers participate in testing

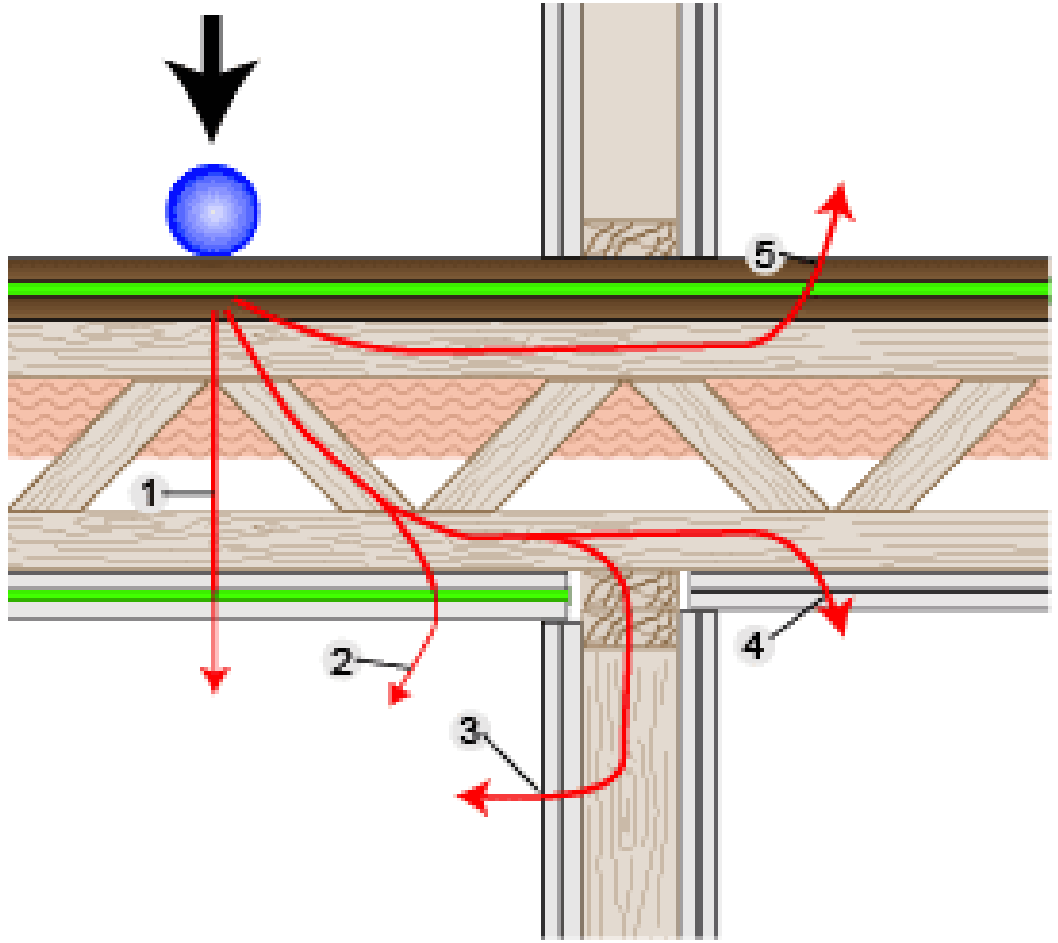


New installation for acoustics. Includes flanking testing.

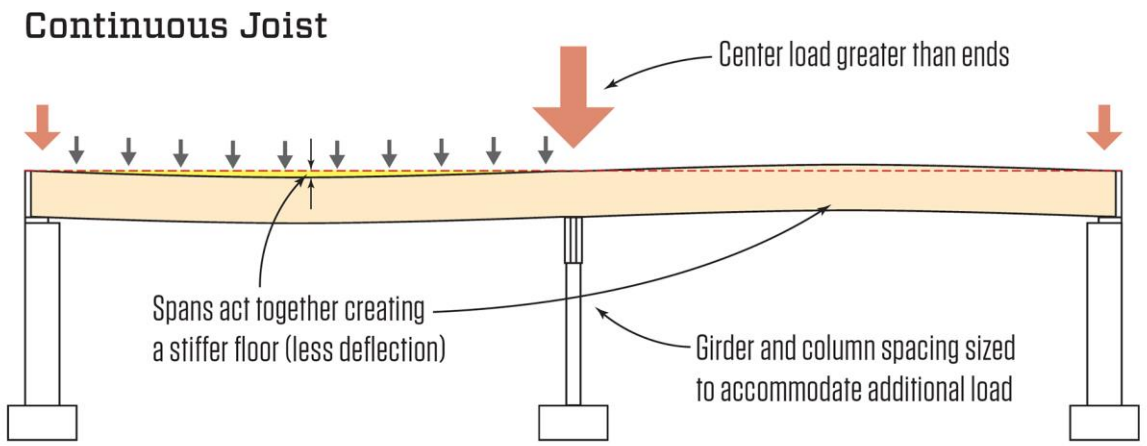
Flanking mitigation

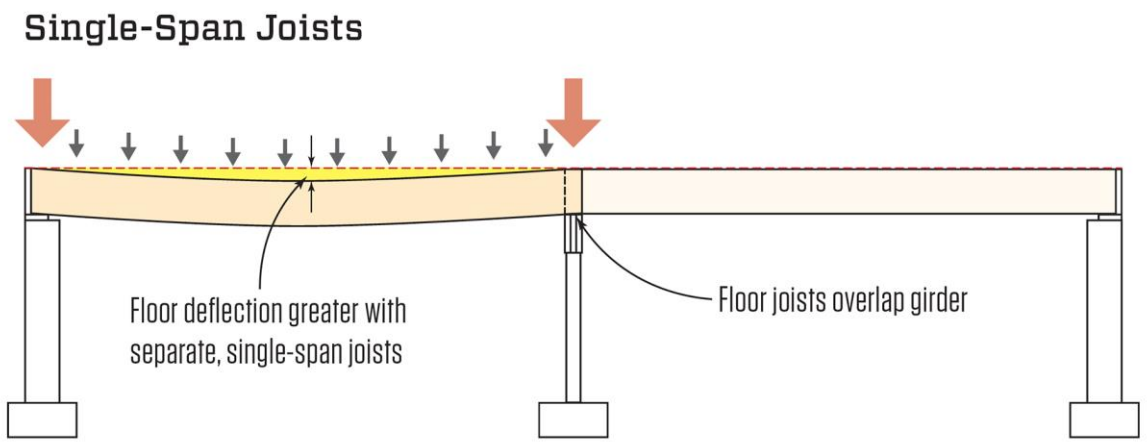
Flanking : Indirect paths by which sound can pass





Flanking mitigation

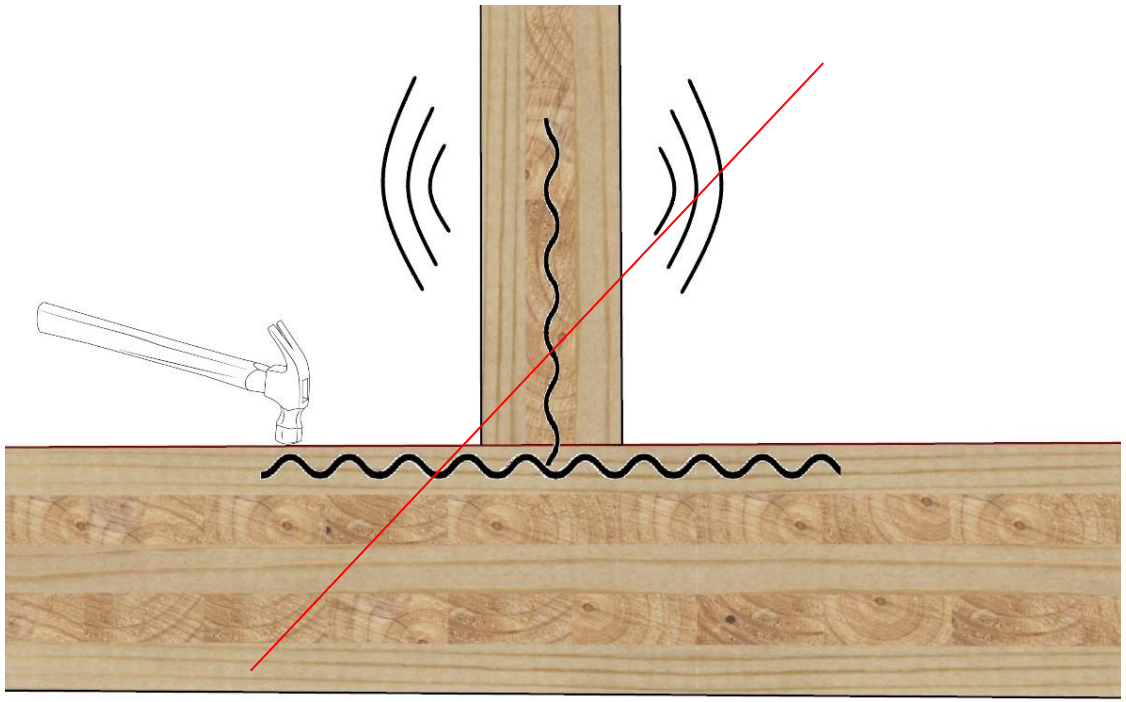


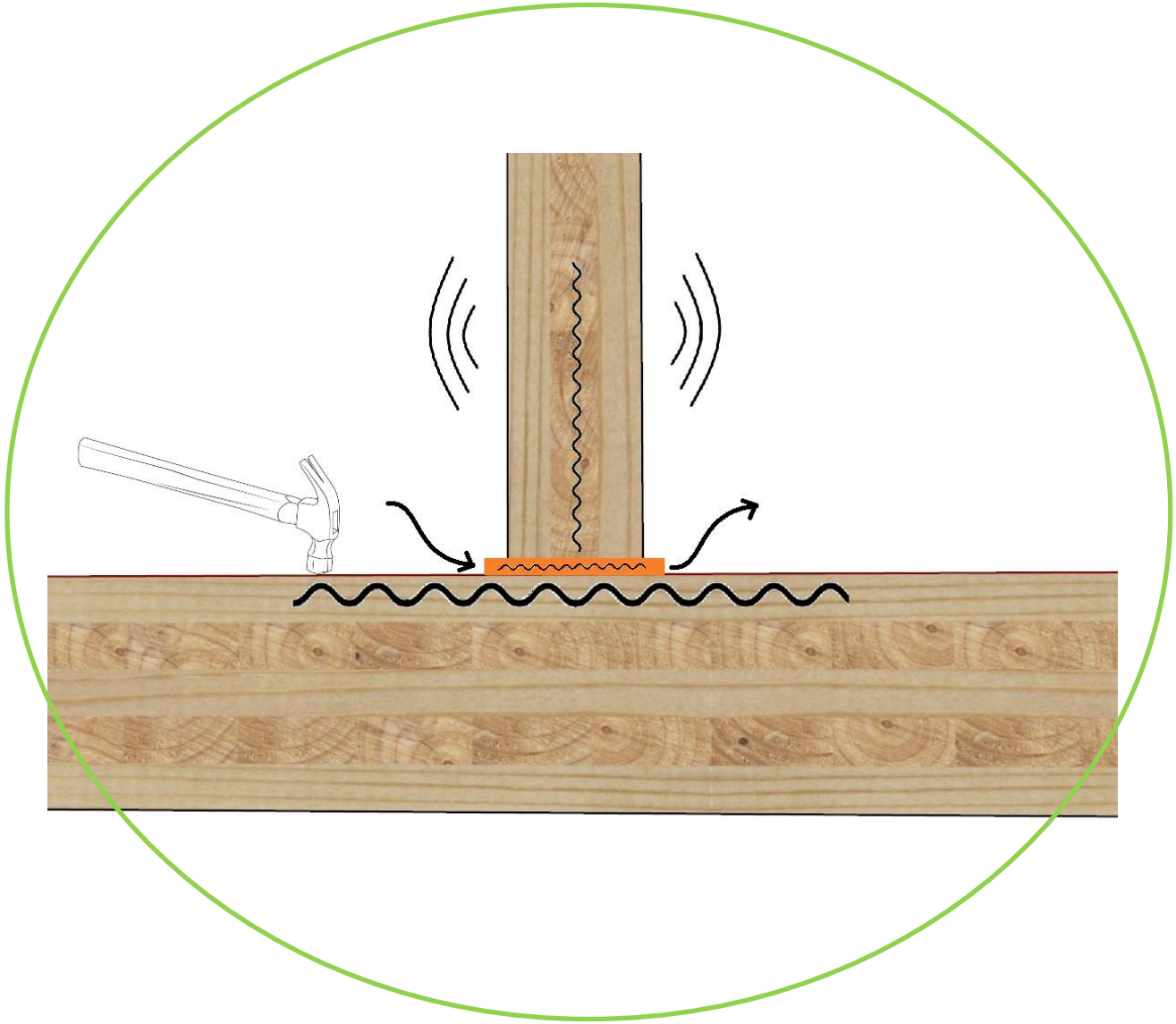


Create discontinuities

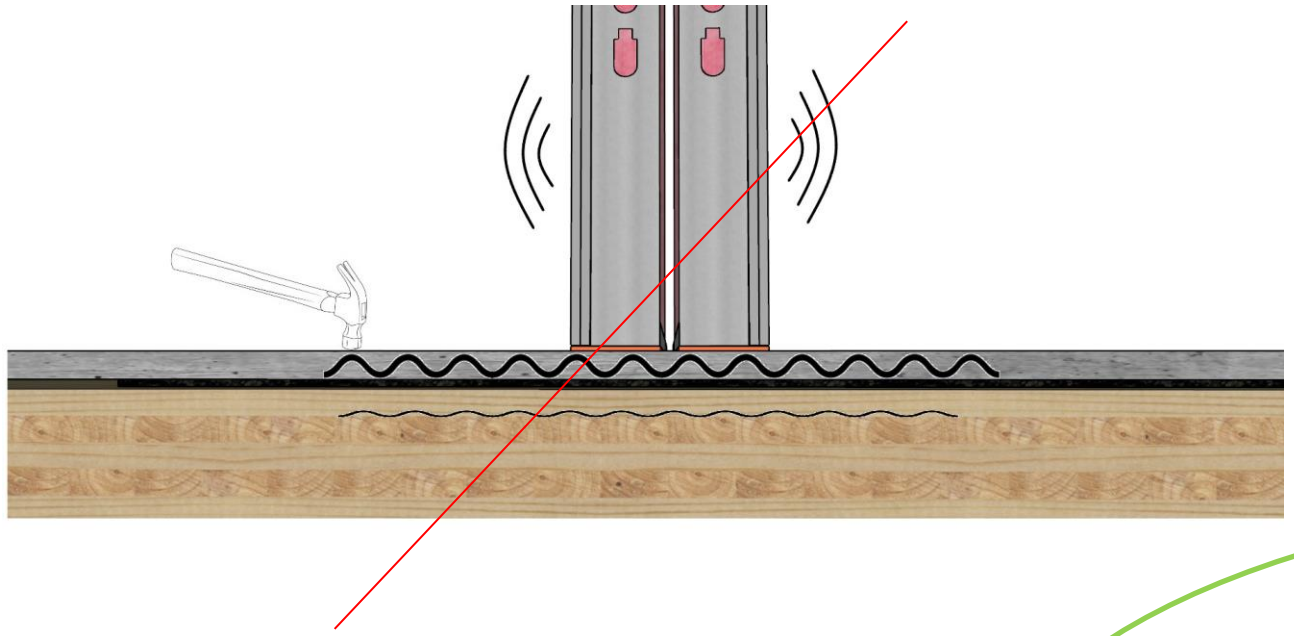
Be cautious when building the layout !

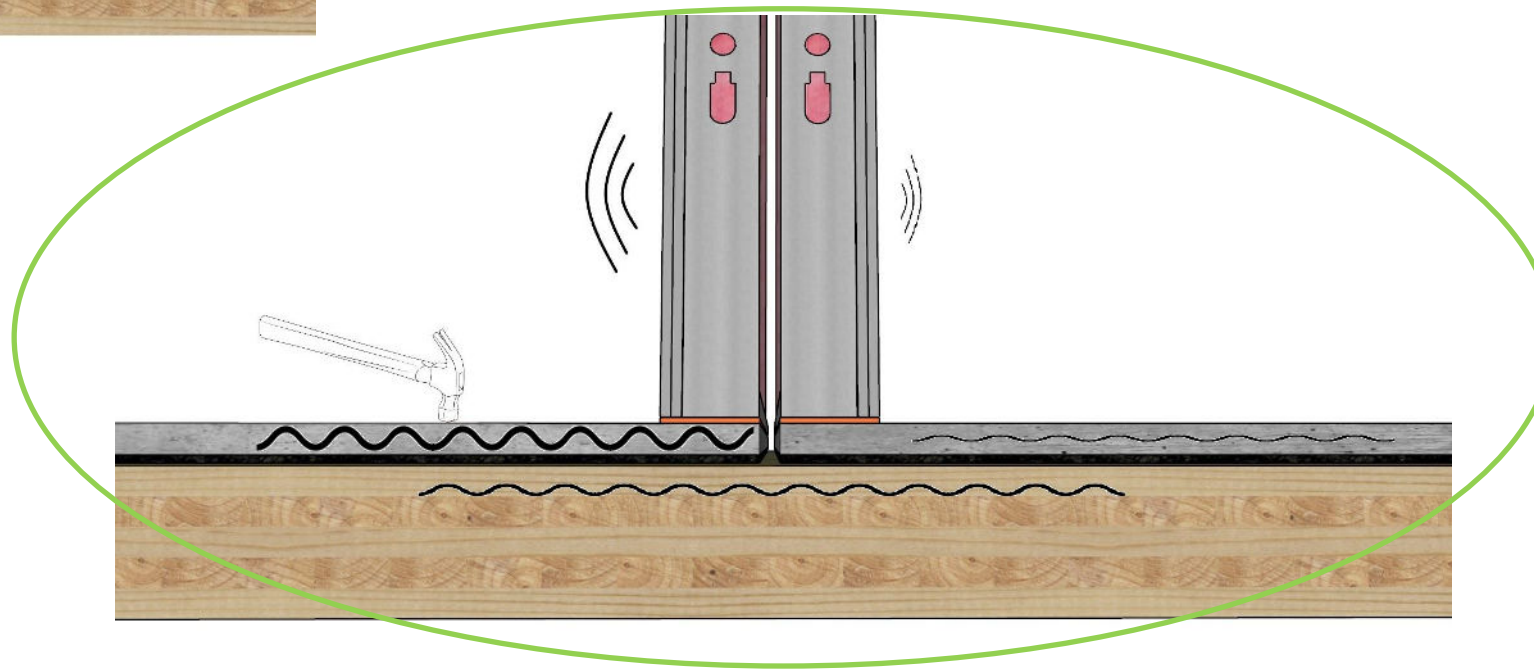
Flanking mitigation





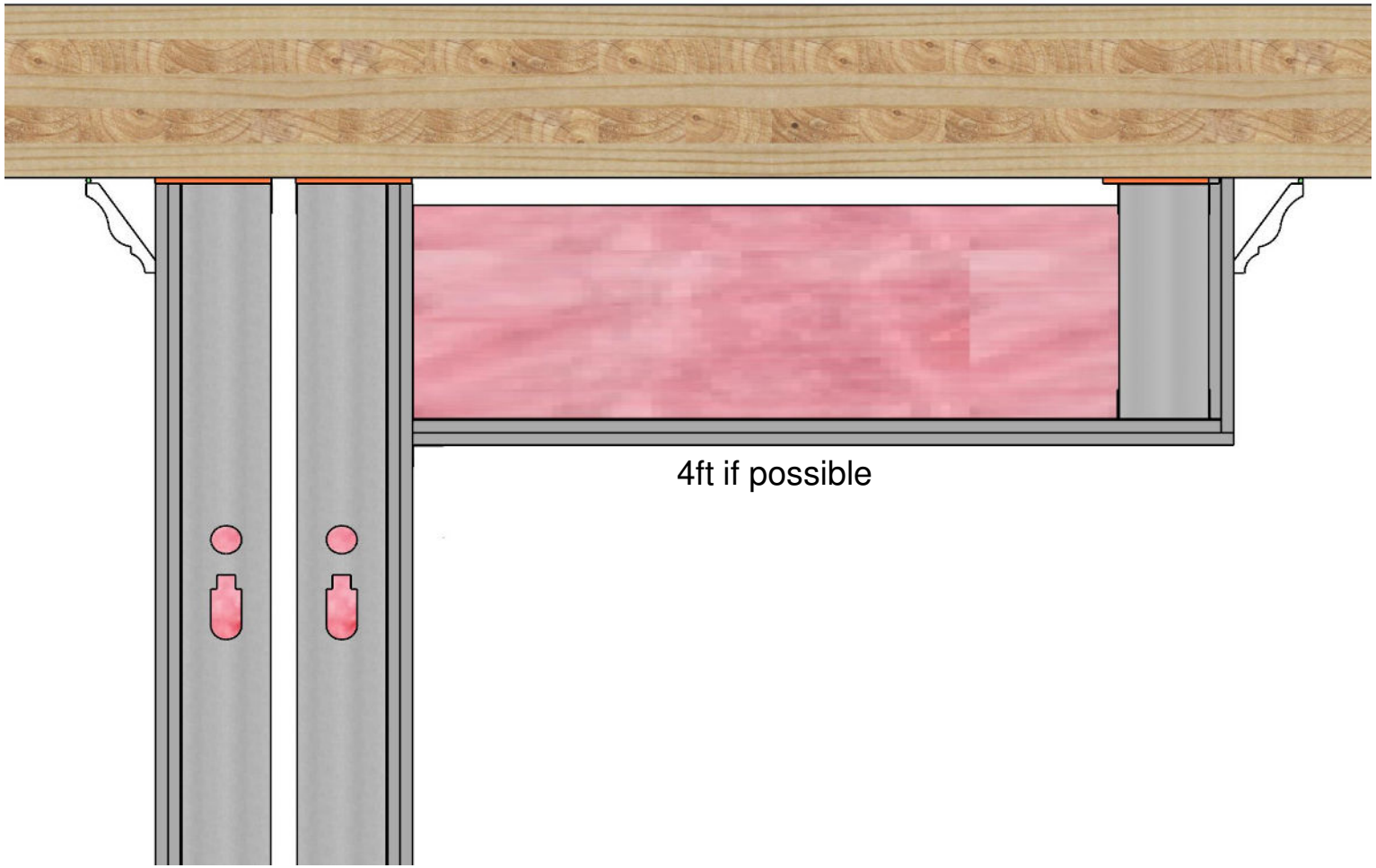
Flanking mitigation



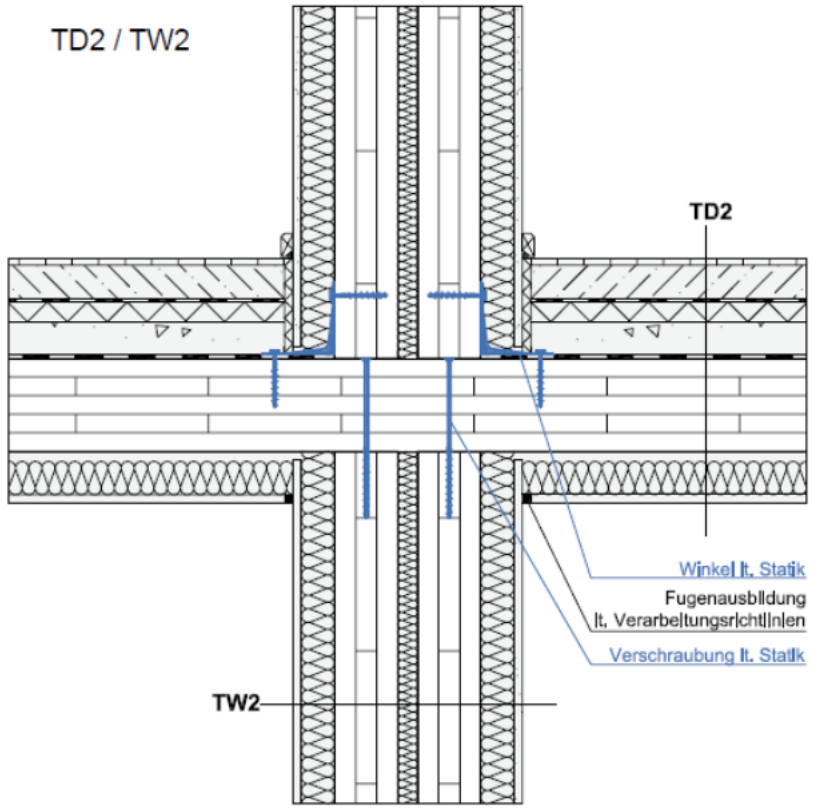


Flanking mitigation

Bulkheads. There are no magic trick



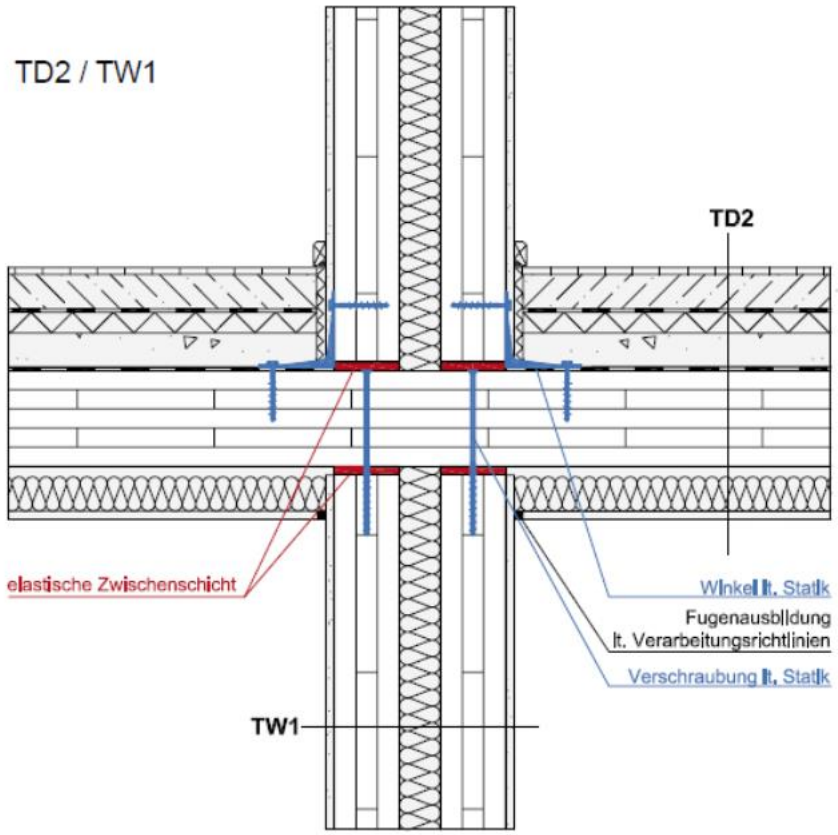
Flanking mitigation



No bearings are required in the case of suspended ceilings and mechanically-isolated facing panels.

rethink.
storaenso

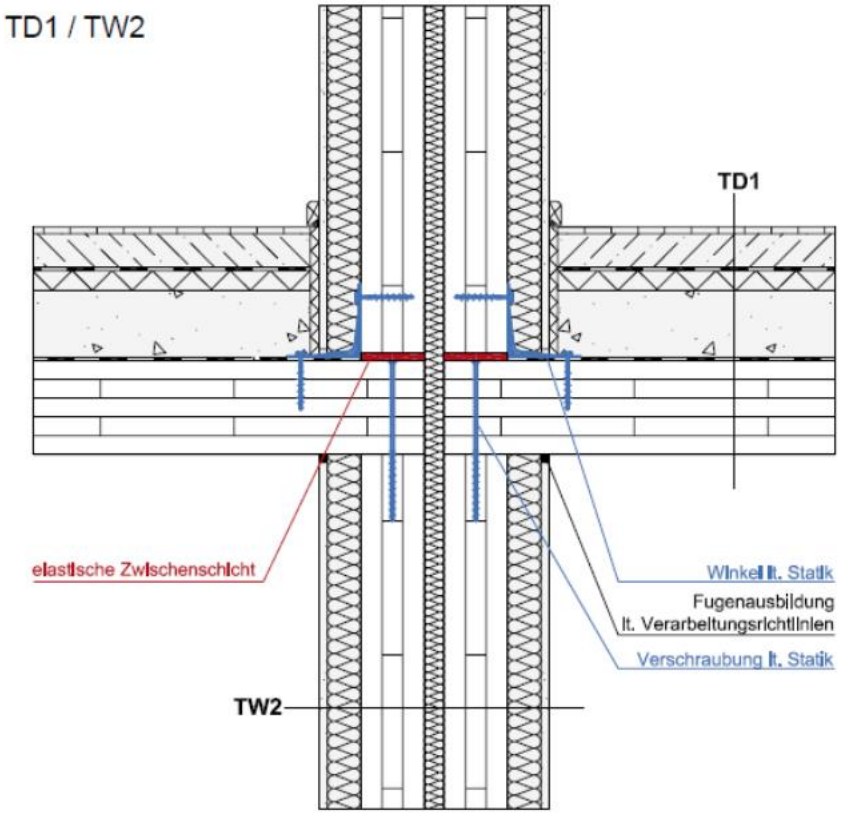
Flanking mitigation



Elastic bearings are required ***above and below the ceiling*** in the case of suspended ceilings without mechanically-isolated facing panels on the walls.

rethink.
storaenso

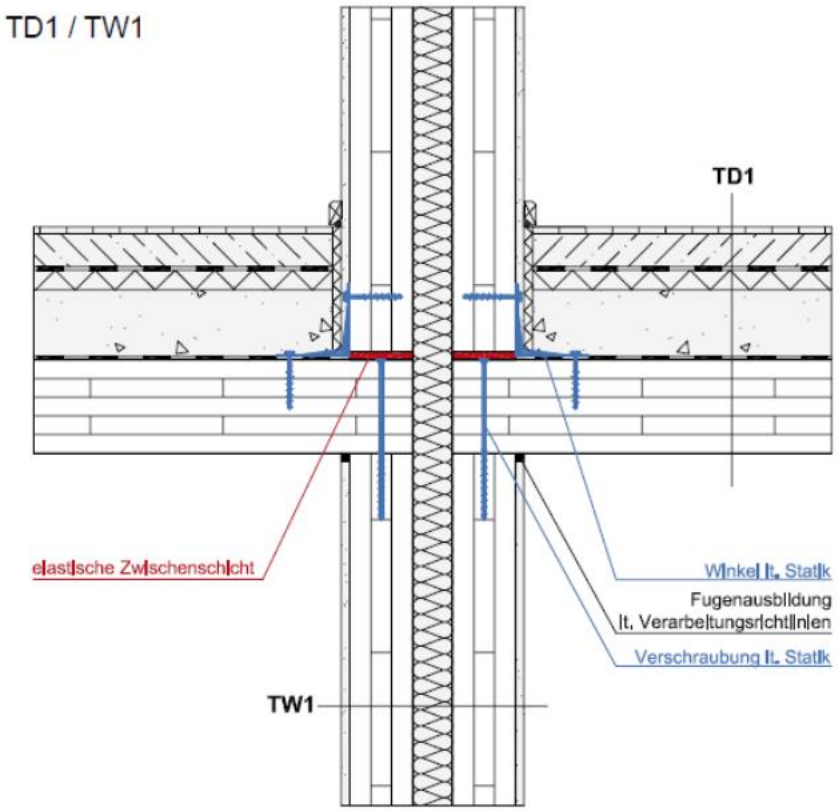
Flanking mitigation



Elastic bearings are required ***above the ceiling*** in the case of cross-laminated timber ceilings with a timber soffit (without a suspended ceiling) and mechanically-isolated facing panels on the walls.

rethink.
stora enso

Flanking mitigation



Elastic bearings are required ***above the ceiling*** in the case of cross-laminated timber ceilings with a timber soffit (without a suspended ceiling) and without mechanically-isolated facing panels on the walls.

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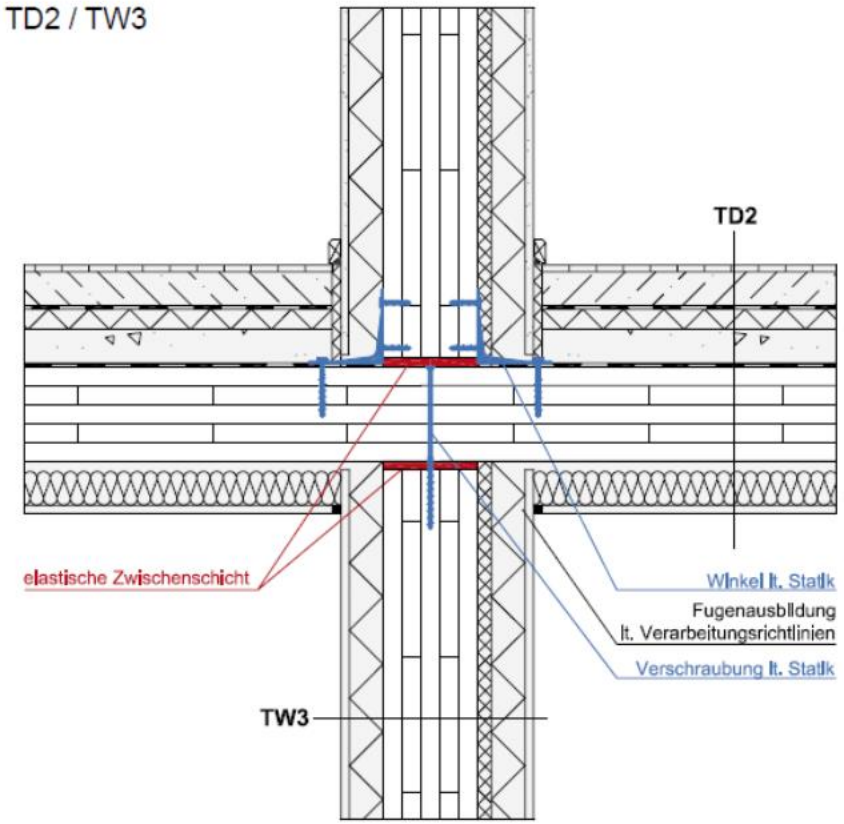
stora enso

Flanking mitigation



Mechanically-isolated facing panels, suspended ceilings and elastic bearings above and below the ceiling are always required on continuous ceilings above different parts of the building.

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storaenso

Flanking mitigation

Long story short…

- The panel is continuous : Use elastic bearings unless nothing is exposed and isolators/decoupling is well done.
- The panel is discontinuous : Use elastic bearings wherever the structure is exposed.
- The panel is discontinuous and the structure is not exposed : Elastic bearings are not needed as long as the decoupling is great.
- **Both sides of demising walls should always use resilient materials.**

rethink.
storaenso

Conventional solution for mass timber (with topping)

<u>Without flooring</u>

38mm concrete : IIC 49 (NRC)

70mm concrete : IIC 46 (NRC)

Conventional solution for mass timber (with topping)

AIIC 62 - 65

ASTC 65 - 70

Advantages of an assembly without concrete topping

- Environmentally friendly!
- Sequencing / Time saving (schedule)
- Quick execution / Easy installation
- No drying time
- No humidity in the building
- No concrete leveling required
- Less weight

Latest solutions for mass timber (without topping)

Reference floor : ASTC 36

AIIC 55 - 58

ASTC 55

IIC 58 (Intertek)

STC 61 (Intertek)

AIIC 41 - 43

ASTC 46 - 48

AIIC 47 - 49

ASTC 49 - 52

Interesting & relevant tools for architects

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:

Interesting & relevant tools for architects

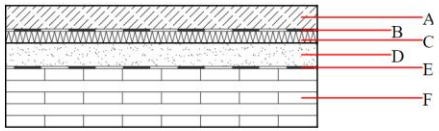
dataholz.eu

Building materials Components

Reviewed/approved components > Intermediate floor > gdmnxn02

Scope ◉ All components ○ Germany

Cross section | Structure



intermediate floor gdmnxn02

intermediate floor solid wood construction, without lining, wet, with filling

Register of building materials used for this application, cross-section (from top to bottom)

	Thickness [mm]	Building material	Thermal performance λ	μ min – max	ρ	c	Reaction to fire
A	60,0	cement screed	1,330	50-100	2000	1,080	A1
B		plastic separation layer	0,200	100000	1400	1,400	E
C		- variable insulation material					
D		- variable building material					
E		trickling protection					E
F		- variable building material					

Variations of building components

	Thickness of layer				Note	Fire performance	Thermal performance		Acoustic performance		Eco Sustainability	Mass
		Thickness [mm]	Building material	Σ		REI	U [W/(m²K)]	Diffusion	$L_{n,w}(C_i)$	$R_w(C,C_{tr})$	ΔOI3	m [kg/m²]
gdmnxn02-00	C D F	30,0 60,0 140,0	impact sound absorbing subflooring MW-T [s'= 35MN/m³] bonded chippings cross laminated timber, minimum 5-ply, d ≥ 140,0; first layer minimum 26 mm	290,0		60	0,44	adequate	65 (-2)	54 (-2,-6)	49,56	302,7
gdmnxn02-01	C D F	30,0 60,0 140,0	impact sound absorbing subflooring MW-T [s'= 35MN/m³] non-bonded chippings cross laminated timber, minimum 5-ply, d ≥ 140,0; first layer minimum 26 mm	290,0		60	0,44	adequate	57 (-1)	60 (-2,-6)	48,72	296,7
gdmnxn02-02	C D F	30,0 60,0 140,0	impact sound absorbing subflooring MW-T [s'=10 MN/m³] bonded chippings cross laminated timber, minimum 5-ply, d ≥ 140,0; first layer minimum 26 mm	290,0		60	0,43	adequate	60	55	47,76	301,8
gdmnxn02-03	C D F	30,0 60,0 140,0	impact sound absorbing subflooring MW-T [s'=10 MN/m³] non-bonded chippings cross laminated timber, minimum 5-ply, d ≥ 140,0; first layer minimum 26 mm	290,0		60	0,43	adequate	52	62	46,92	295,8
gdmnxn02-04	C D F	30,0 60,0 140,0	impact sound absorbing subflooring MW-T [s'=10 MN/m³] elastic bonded fill (m' aprrox. 90 kg/m²) cross laminated timber, minimum 5-ply, d ≥ 140,0; first layer minimum 26 mm	290,0		60		adequate	46 (-1)	73 (-2,-8)	47,35	300,0
gdmnxn02-05	C D F	30,0 60,0 160,0	impact sound absorbing subflooring MW-T [s'=10 MN/m³] non-bonded chippings, m' approx. 93 kg/m² cross laminated timber, first layer minimum 40mm	310,0	D: fill m' approx. 93 kg/m²; F: first layer minimum 40 mm	90	0,41	adequate	47 (2)	74 (-2,-7)	53,24	325,7

Interesting & relevant tools for architects

Lignumdata

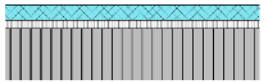
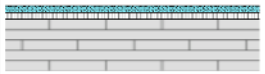
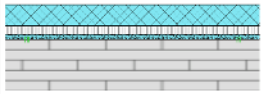
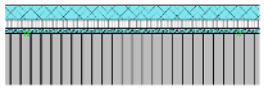
Construction products and components

Home | Components | Products | Wood species

FILTER | **CATALOG FLOOR ASSEMBLY**

- General Information
- Environmental impact per m² co...
- Assembly
- Manufacturer
- Search assembly number
- Sort data
- Reset search criteria

Page **6** of 14. There were **131** matching component found.

Lignum ID-№ Graphic	Base structure Paneling Origin of sound insulation values	Construction height Weight U-value	Values of airborne sound insulation		Values of footfall sound insulation	
A0839 	Solid wood panel	285 mm	**Rw**	60 dB	**Lnw**	55 dB
	with floor construction	206 kg/m²	**C**	-3 dB	**CI**	1 dB
	Verified calculation	≈0.273 W/m²K	**C50-3150**	-6 dB	**CI50-2500**	4 dB
	Detail IFC4 LOD300					
A0841 	Solid wood panel	247 mm	**Rw**	51 dB	**Lnw**	64 dB
	with floor construction	125 kg/m²	**C**	-3 dB	**CI**	1 dB
	Verified calculation	≈0.289 W/m²K	**C50-3150**	-3 dB	**CI50-2500**	1 dB
	Detail IFC4 LOD300					
A0842 	Solid wood panel	325 mm	**Rw**	64 dB	**Lnw**	51 dB
	with floor construction	288 kg/m²	**C**	-3 dB	**CI**	0 dB
	Verified calculation	≈0.268 W/m²K	**C50-3150**	-7 dB	**CI50-2500**	5 dB
	Detail IFC4 LOD300					
A0844 	Solid wood panel	300 mm	**Rw**	61 dB	**Lnw**	54 dB
	with floor construction	222 kg/m²	**C**	-3 dB	**CI**	1 dB
	Verified calculation	≈0.269 W/m²K	**C50-3150**	-7 dB	**CI50-2500**	5 dB
	Detail IFC4 LOD300					
A0846 	Solid wood panel	262 mm	**Rw**	52 dB	**Lnw**	63 dB
	with floor construction	141 kg/m²	**C**	-3 dB	**CI**	1 dB
	Verified calculation	≈0.285 W/m²K	**C50-3150**	-3 dB	**CI50-2500**	1 dB
	Detail IFC4 LOD300					

Rule of thumb – ISO to ASTM

Rw is very similar to STC and defines the sound insulation of a partition. Rw 55 can be interpreted as STC 55 (or should be close).

Ln,w indicated the impact sound insulation and can be roughly converted to IIC by applying the simple following equation :
IIC = 110 – Ln,w

29 billion $ in damages (2022)

Global GHG Emissions

Decarbonizing the economy

Montreal Sets Zero-Emission Target for All New Buildings by 2025

May 6, 2022 Reading time: 2 minutes

Toronto is the latest city to crackdown on carbon-heavy building materials

There's mounting awareness around the carbon intensity of garden-variety materials such as cement, concrete, steel, glass and aluminum

BY JOHN LORINC
MAY 25, 2023

Decarbonizing the economy

July 10, 2021

State Public Procurement Reduces Carbon

by Meghan Lewis
Senior Researcher, Carbon Leadership Forum

States are taking big steps on embodied carbon action this legislative session. Procurement policies related to embodied carbon were introduced in eight states in 2021, including Washington, Oregon, California, Colorado, Minnesota, Connecticut, New York, and New Jersey.

Embodied Carbon

Cement & Steel = 20% of Global GHG Emissions [1]

1 Source: https://www.ledevoir.com/environnement/697041/environnement-donner-une-deuxieme-vie-carboneutre-a-un-immeuble

Why build with wood

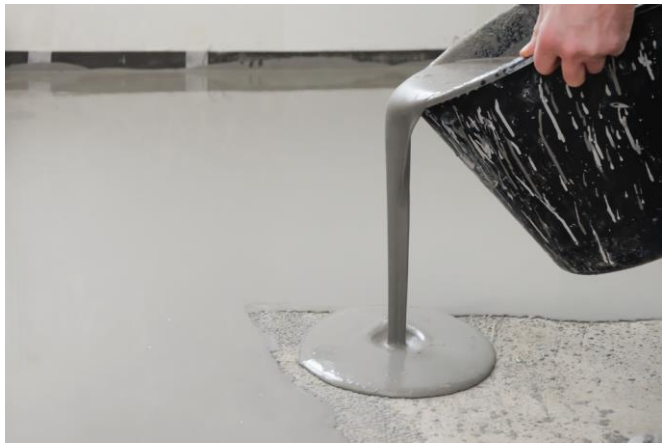
For a sustainable transition in construction

* Source: https://cecobois.com/pourquoi-construire-en-bois/

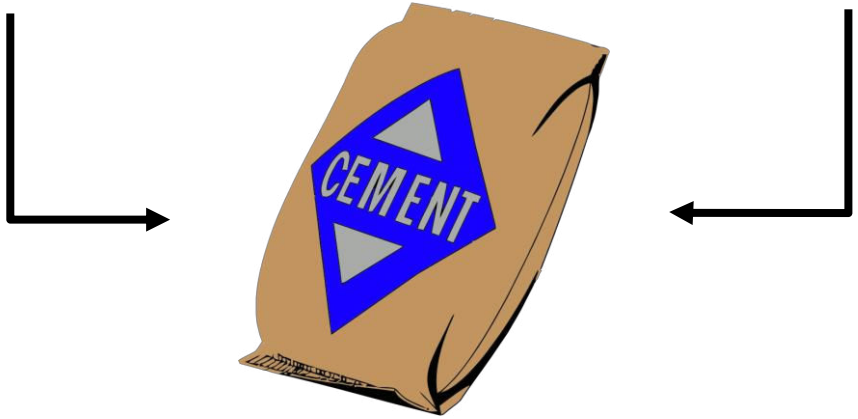
Types of toppings to soundproof floors

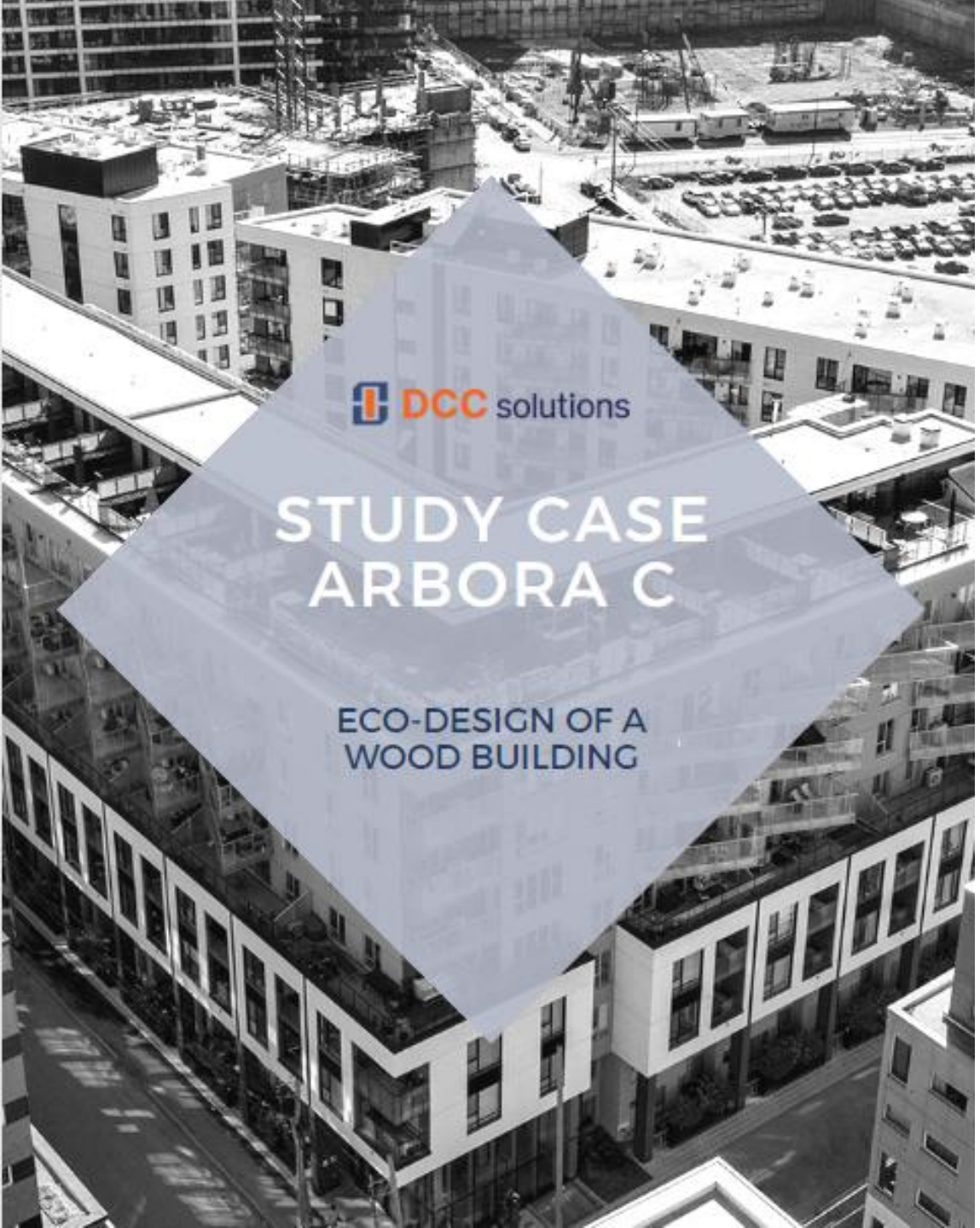
Mortar bed ("screed")

Concrete topping (self-levelling)



Dry topping solutions





Objective of study:

To assess the impact of building design choices with an outlook of reducing GHG emissions from materials used in tall wooden buildings. This report focuses on the reductions in the carbon footprint (or GHG) that can be achieved through a building eco-design approach.

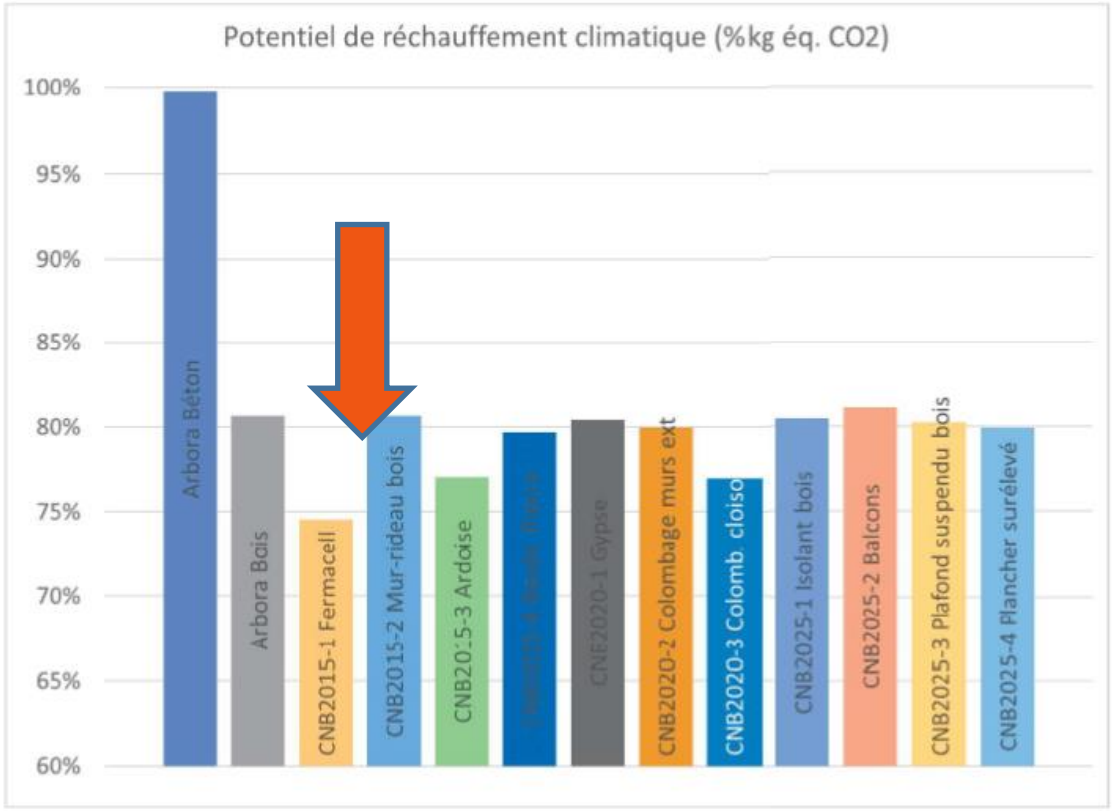


Figure 17. Potentiels de réchauffement climatique relatifs des scénarios

Conclusion:

The scenario of replacing the concrete screed by fiber gypsum panels has the greatest impact on the carbon footprint of the building.

Structural materials savings

4 LIGHTWEIGHT

CONCRETE TOPPING	DRY TOPPING
15-20 lbs/ft2	5.3 lb/ft2 OR LESS

Significant structural support weight reduction VS a concrete topping.

Environmental certifications

EPD: Environmental Product Declaration

Life Cycle Analysis

Health Product Declaration (Non-toxic ingredients)

Indoor Air Quality (VOC Emissions)

LEED Certification

Does not certify products, only projects

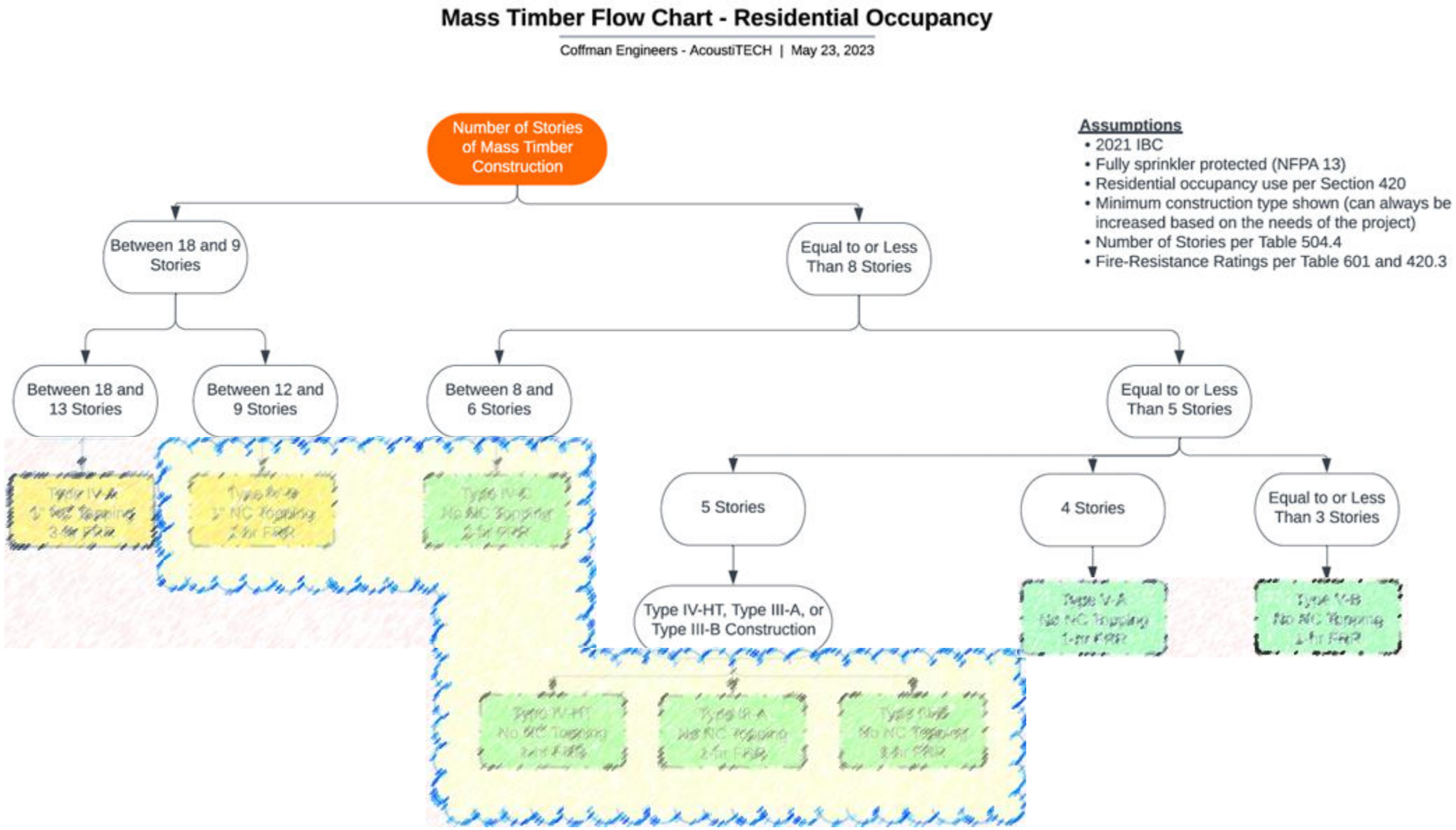
SUSTAINABILITY CONTRIBUTION DECLARATION

Contribution to LEED v4®
(Leadership in Energy and Environmental Design)

Reference: LEED v4 BD+C: New Construction

What’s next ?

What’s next ?


Mass Timber Flow Chart - Residential Occupancy
Coffman Engineers - AcoustiTECH | May 23, 2023
Number of Stories of Mass Timber Construction
Between 18 and 9 Stories
Equal to or Less Than 8 Stories
Between 18 and 13 Stories
Between 12 and 9 Stories
Between 8 and 6 Stories
Equal to or Less Than 5 Stories
5 Stories
4 Stories
Equal to or Less Than 3 Stories
Type IV-HT, Type III-A, or Type III-B Construction
Assumptions
• 2021 IBC
• Fully sprinkler protected (NFPA 13)
• Residential occupancy use per Section 420
• Minimum construction type shown (can always be increased based on the needs of the project)
• Number of Stories per Table 504.4
• Fire-Resistance Ratings per Table 601 and 420.3

INTEGRATED SUPPORT

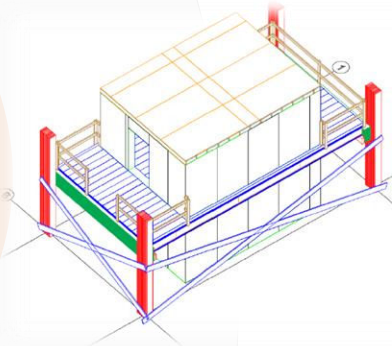
DETAIL REVIEW & CREATION

ON-SITE/OFF-SITE TESTING

AcoustiTECH

PERFORMANCE CREDIBILITY EXPERTISE

CONCEPTUAL DESIGN



CODE COMPLIANCE

MATERIAL ANALYSIS

Questions and inquiries

Tech-support@acousti-tech.com

Thank you

AcoustiTECH