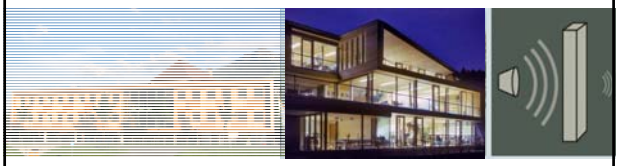
University of Innsbruck / Timber Engineering Unit

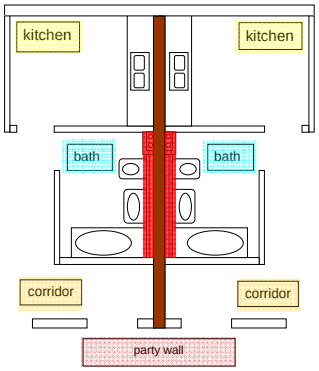
holzbaulehrstuhl
Universität Innsbruck

Dealing with Acoustic Issues in Multifamily Housing

Asst.-Prof. DI Dr. techn. Anton Kraler



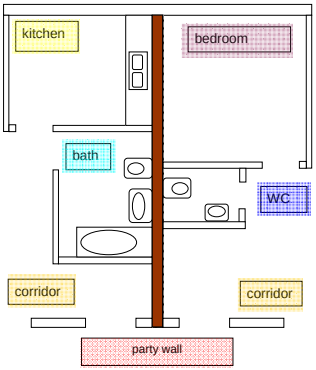
Sound insulation begins with planning



Good example

- ground plan
- mechanical shafts
- no weakening of the party wall
- front wall installation

Sound insulation begins with planning

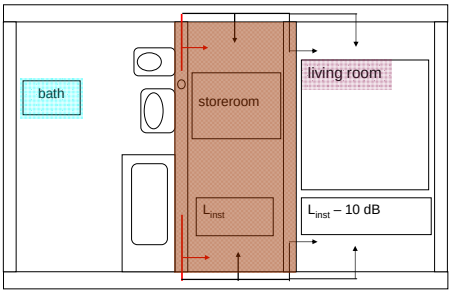


Poor Example

- ground plan
- no mechanical shafts
- no front wall installation
- Mechanical wall continues into the bedroom wall

Reduced sound transmission

by a buffer space



Which material is used

Visible wood surfaces

Which material is used

Combination of wood and clay

Which material is used

Facings - mineral building panels (e.g. sheet rock)

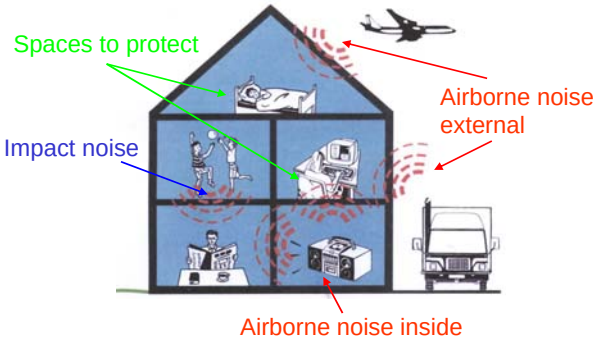
Which material is used

Plastic or wood-based panels - smooth surfaces

Which material is used

Material selection - exterior facade

Why is sound insulation important?



Sound transmissions

Airborne noise

Transmission medium: Air
Examples: speech, music, vehicles,

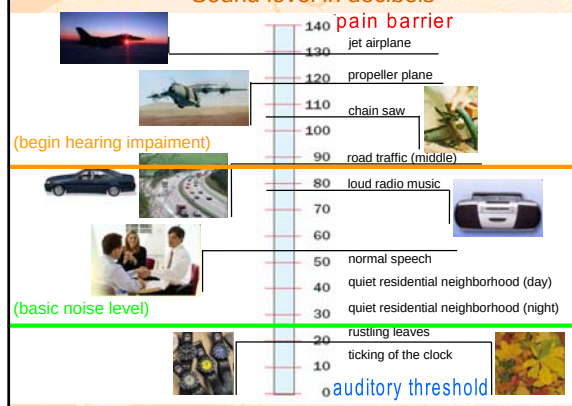
Structure borne noise

Transmission medium: solid or liquid substances
Examples: close doors, to drill, to nail,

Impact noise

Impact noise is a particular form of structure borne noise.
Transmission medium: solid or liquid substances
Examples: moving chairs, walking

Sound level in decibels



Summary - Austrian code specification

airborne noise

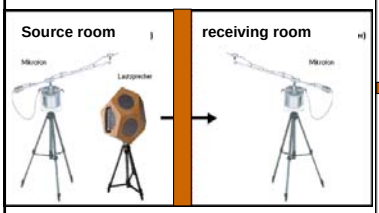
• party wall	$D_{nt,w}$	≥	55 dB
• ceiling	$D_{nt,w}$	≥	55 dB
• entrance door	R_w	≥	42 dB

impact noise

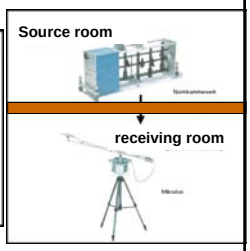
• ceiling	$L_{nt,w}$	≤	48 dB
• stairs, landings	$L_{nt,w}$	≤	50 dB

How is sound measured?

Airborne noise



Impact noise



Airborne sound insulation

Single-layer parts

Parameters: mass per unit area
bending stiffness

Doubling the Mass: m' → 2 m' ⇒ R → R + 6 dB

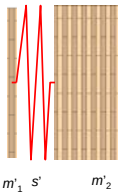
thick element > 6 in >250kg/m³ (15.56lb/ft³)
⇒ low critical frequency below 100 Hz
⇒ bending resistant parts

thin element < 1 in
⇒ high critical frequency above 2500 Hz
⇒ soft bending parts

Airborne sound insulation

Double-layer parts

Simplified model:
mass - spring - mass

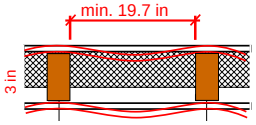


A 10 dB - 15 dB improvement in sound insulation is possible if we use a soft bending facing!

Multi-layered wall structures

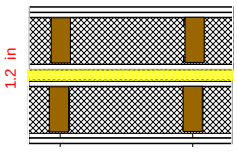
Example: interior wall

Rw > 45 dB



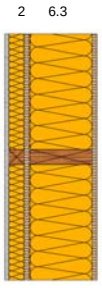
Example: party wall

Rw > 70 dB (Dnt,w = 60 dB)

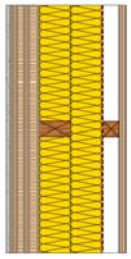


Details exterior walls

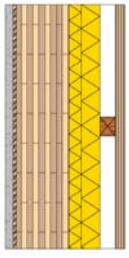
Dimensions in inches



$R'_{45°,w}$ = 43 dB



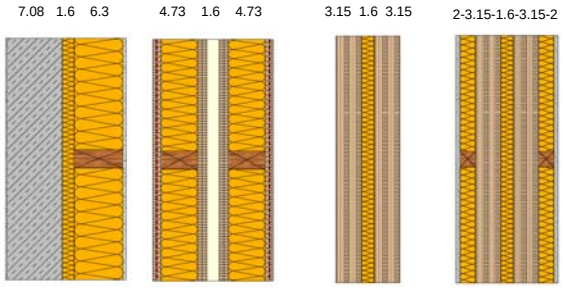
$R'_{45°,w}$ = 44 dB



$R'_{45°,w}$ = 53 dB

Details party walls

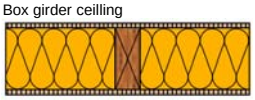
Dimensions in inches



$D'_{nT,w}$ = 74 dB $D'_{nT,w}$ = 66 dB $D'_{nT,w}$ = 52 dB $D'_{nT,w}$ = 64 dB

Measurement examples ceiling slab

Box girder ceilling

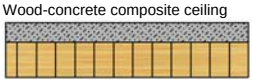


$D'_{nT,w}$ = 37dB, $L'_{nT,w}$ = 78dB

Cross laminated timber ceiling

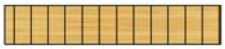
$D'_{nT,w}$ = 40dB, $L'_{nT,w}$ = 83dB

Wood-concrete composite ceiling



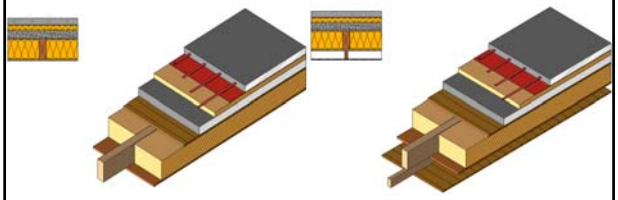
$D'_{nT,w}$ = 45dB, $L'_{nT,w}$ = 84dB

Glue laminated timber ceiling



$D'_{nT,w}$ = 40dB, $L'_{nT,w}$ = 83dB

Details: box girder ceilling



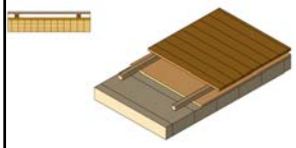
with suspended ceiling

$D'_{nT,w}$ = 50dB, $L'_{nT,w}$ = 56dB

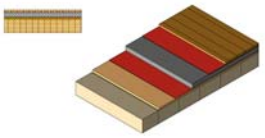
without suspended ceiling

$D'_{nT,w}$ = 62dB, $L'_{nT,w}$ = 56dB

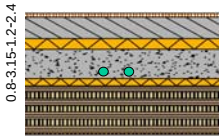
Details: cross laminated timber / glued laminated timber



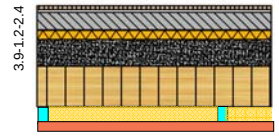
$D'_{nT,w}$ = 45dB, $L'_{nT,w}$ = 68dB



$D'_{nT,w}$ = 50dB, $L'_{nT,w}$ = 56dB

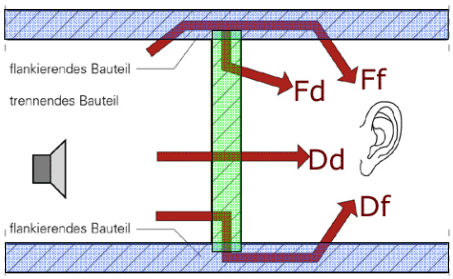


$D'_{nT,w}$ = 56dB, $L'_{nT,w}$ = 45dB



$D'_{nT,w}$ = 54dB, $L'_{nT,w}$ = 48dB (42dB)

Transmission paths - directly and over the flanks

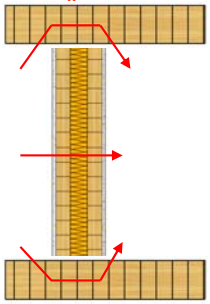


>Total there are: 1 + 3 x 4 = 13 Transmission paths<

Transmission paths - directly and over the flanks

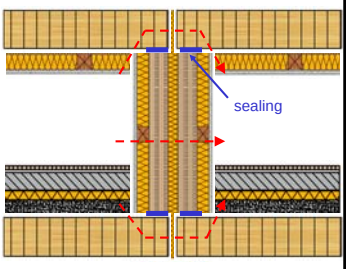
without a joint

$\Rightarrow R'_w$ = 39 dB



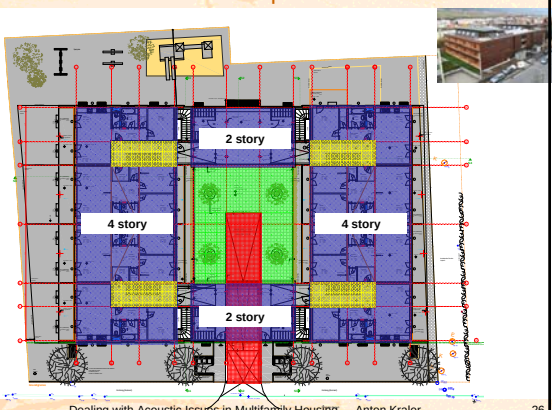
with a joint

$\Rightarrow R'_w$ = 51 + 15 + 7.5 = 73.5 dB

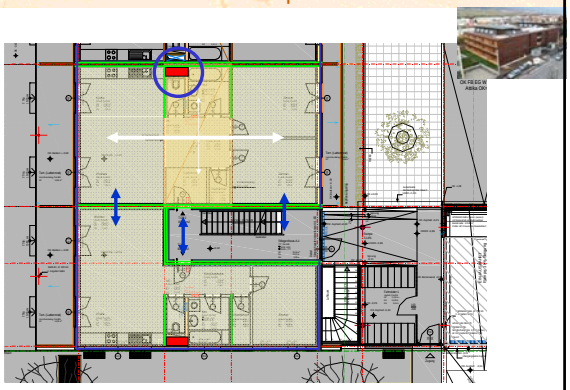


4-story residential wood building

Location plan

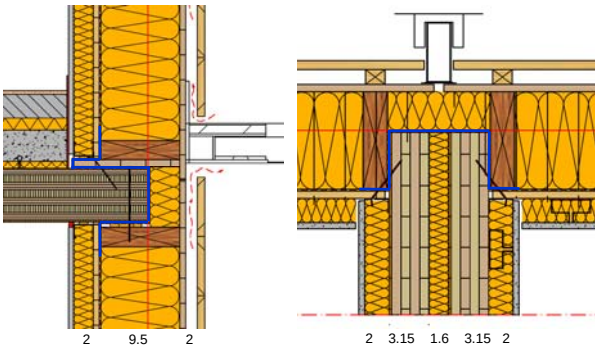


Location plan

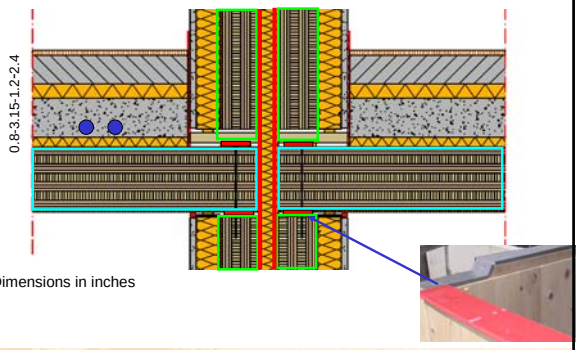


Detail – Party Wall and Exterior Wall

Dimensions in inches

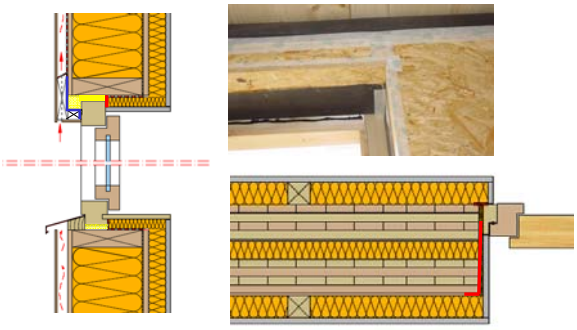


Detail – Party Wall and Ceiling

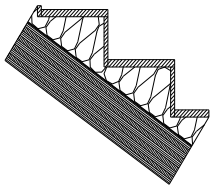


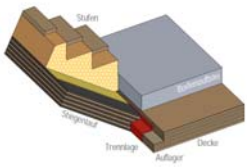
Dimensions in inches

connection details – window and entrance door

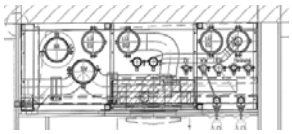


Stairs details





Installation shaft (heating, water, etc.)



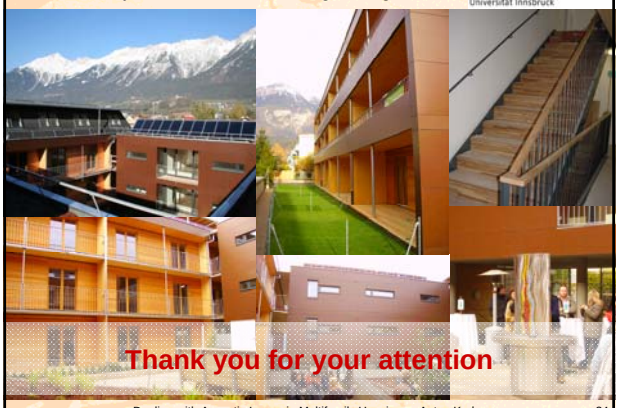
Summary

Principles for satisfactory sound protection in timber construction

- Use flexible, sound dissipating walls, solid wood elements require flexible finishing layers
- Decouple massive wood elements from flexible finishing layers
- Cavities always need dampening
- Use heavy ballast on wood floors for adequate noise dampening > 1300 kg/m³
- Air tightness is essential, especially around windows and entrance doors in case of high sound control requirements
- Avoid sound bridges

University of Innsbruck / Timber Engineering Unit

holzbaulehrstuhl
Universität Innsbruck



Thank you for your attention