

Contribution from SINTEF Building & Infrastructure

Multy storey wooden constructions and sound

What works well and what does not

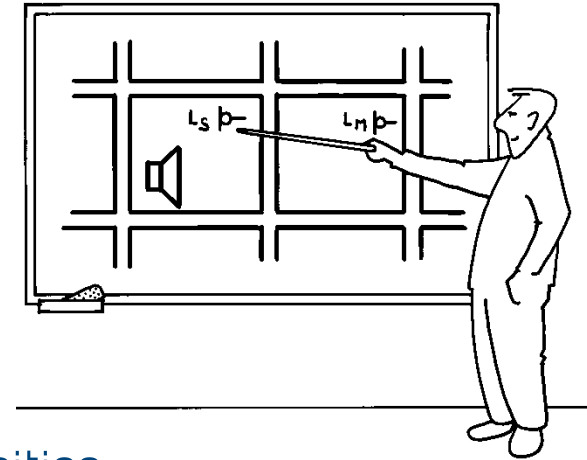
Forum HolzBau Nordic

Anders Homb

September 2014

Outline

- Sound insulation requirements & recommendations
- Flanking transmission matters
- Residential buildings
 - wall & floor constructions, challenges & opportunities
- Schools, kindergarten & hospitals
 - challenges & alternatives
- Offices
 - challenges & alternatives
- Summary of opportunities & challenges



Sound insulation requirements

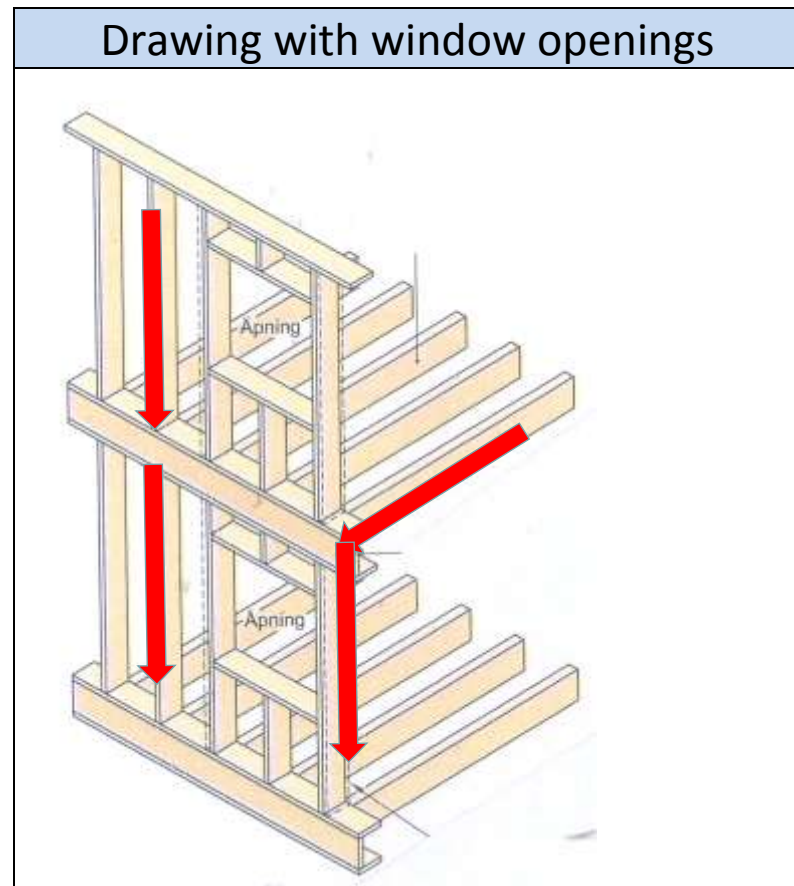
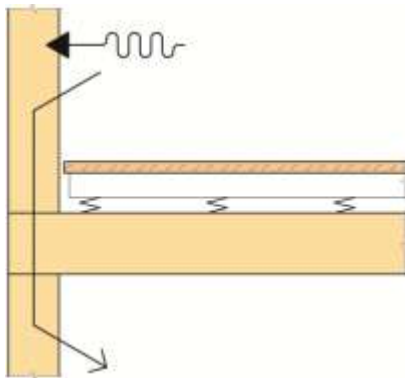
- **Norwegian requirements: 3 main levels**

TYPE of building	Airborne sound insulation, R'_w (dB)	Impact sound insulation $L'_{n,w}$ (dB)
Residential buildings	≥ 55 OBS	≤ 53 OBS
School,	≥ 48	$\leq 63/58$
Kindergarten	≥ 48	$\leq 63/58$
Hospital	≥ 48	≤ 58
Office building	$\geq 37-48$	$\leq 63/58$

- **OBS:** Research and experiences shows that more strict requirements are necessary - at low frequencies= **Recommendations**
i.e : Include Spectrum adaptation term $C_{50-5000}/C_{i,50-2500}$

Load bearing solution & flanking transmission

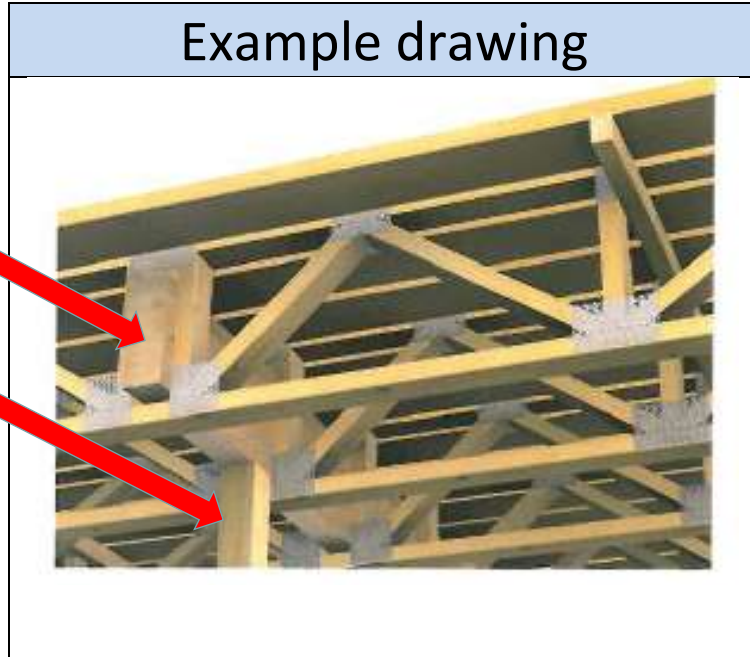
- **Timber frame or CLT concept**
- - **challenging**
 - wall-to-wall and floor-to-wall path limits the sound insulation



Load bearing solutions & flanking transmission

- **Beam and column concept**
- - **preferable** when integrated beam is possible
- limits the flanking transmission

Example drawing



Wind load stiffening of larger buildings

- **Vertical stiffening layer**
and/or
- **Horizontal stiffening layer**
 - flanking transmission
limits the sound insulation
more or less
- **Challenge:** Combination of
sound insulation &
stiffening solution





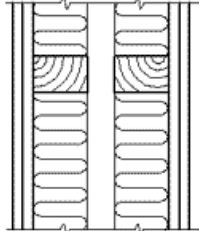


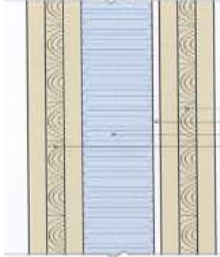


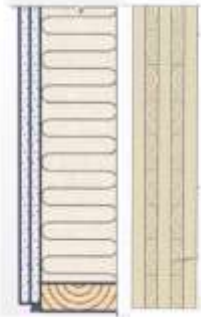
Residential buildings

Wall constructions

- **Separate wall constructions**

- Left hand traffic light:
Requirements

Right hand traffic light:
Recommendations

WALL constructions	Principal solutions
Timber stud constructions  	
CLT constructions  	
Hybrid Timber stud and CLT constructions  	

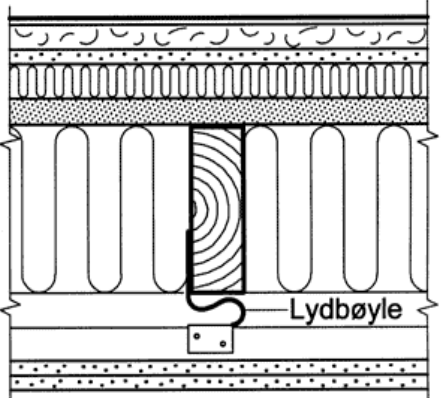
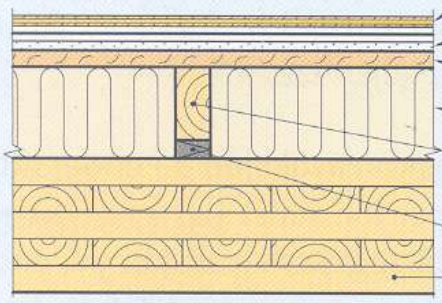
Residential buildings

Floor constructions

- **Connected floor construction elements**

- Left hand traffic light: **Requirements**

Right hand traffic light: **Recommendations**

FLOOR constructions	Principal solutions
<p>Timber beam constructions</p> <ul style="list-style-type: none"> - very common in Norway - unsatisfactory low frequency properties <div style="display: flex; justify-content: center; gap: 20px;"> <div style="width: 30px; height: 30px; background-color: #4CAF50; border-radius: 50%;"></div> <div style="width: 30px; height: 30px; background-color: #F44336; border-radius: 50%;"></div> </div>	
<p>CLT constructions</p> <ul style="list-style-type: none"> - unsatisfactory low frequency properties <div style="display: flex; justify-content: center; gap: 20px;"> <div style="width: 30px; height: 30px; background-color: #4CAF50; border-radius: 50%;"></div> <div style="width: 30px; height: 30px; background-color: #F44336; border-radius: 50%;"></div> </div>	

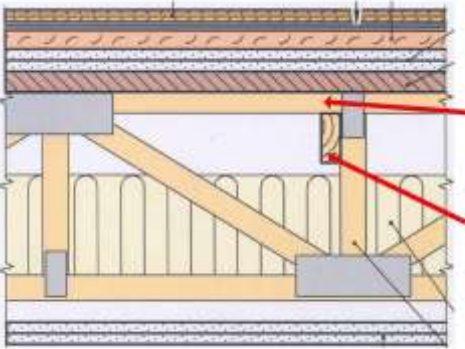
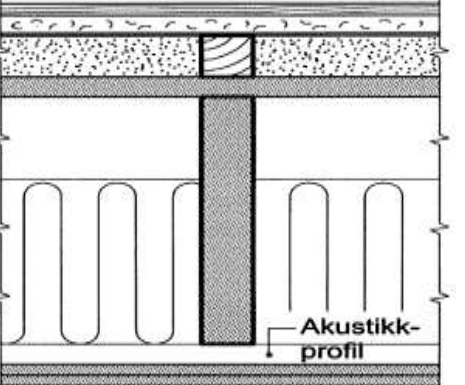
Residential buildings

Floor constructions

- **Connected floor construction elements**

- Left hand traffic light: **Requirements**

Right hand traffic light: **Recommendations**

FLOOR constructions	Principal solutions
<p>Stiffened wood joist floor - improved low frequency properties</p> <p>When low flanking transmission</p>	 <p>Stiffening support between beams</p> <p>Transverse stiffener at each vertical post</p>
<p>Hybrid timber beam and heavy constructions (concrete or sand) - seldom used</p> <p>When low flanking transmission</p>	 <p>Akustikk-profil</p>

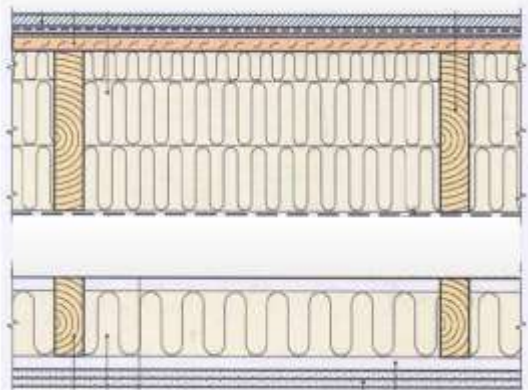
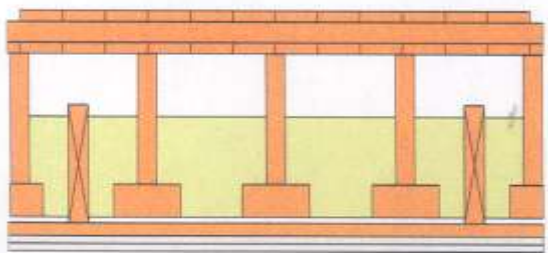
Residential buildings

Floor constructions

- **Separate floor construction elements**

- Left hand traffic light: **Requirements**

Right hand traffic light: **Recommendations**

FLOOR constructions	Construction examples
<p>Timber beam constructions - different experiences</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="width: 40px; height: 40px; background-color: #4CAF50; border-radius: 50%;"></div> <div style="width: 40px; height: 40px; background-color: #FFEB3B; border-radius: 50%;"></div> </div>	
<p>Combination of CLT and timber beam</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="width: 40px; height: 40px; background-color: #4CAF50; border-radius: 50%;"></div> <div style="width: 40px; height: 40px; background-color: #D7CCC8; border-radius: 50%; text-align: center; line-height: 40px;">?</div> </div>	

Schools, kindergarten & hospitals

Opportunities & challenges

- **Ordinary rooms:**

Airborne sound, R'_w -value: 7 dB below requirement in residential buildings

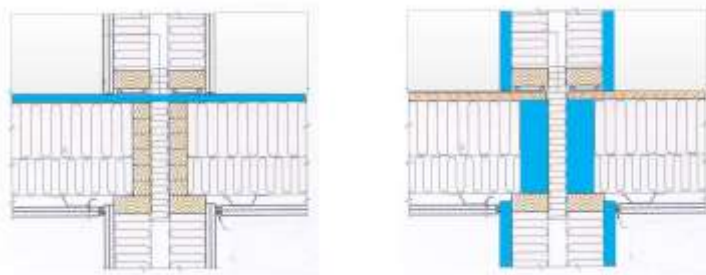
Impact sound, $L'_{n,w}$ -value: 5 (10) dB above requirements in resid.buildings

HUGE opportunities to choose wooden constructions

- **Alternative 1:**

Same wall or floor construction as residential buildings

- permit flanking transmission contribution of approximately 5 dB



Schools, kindergarten & hospitals

Opportunities & challenges

- **Alternative 2:**

- Less complex wall or floor construction **combined with**
- Tuned flanking transmission (load bearing and stiffening construction)

Office buildings

- **"Standard" rooms:**

Impact sound, $L'_{n,w}$ -value: 5 (or 10) dB above requirements in resid.buildings
HUGE possibilities to choose wooden constructions

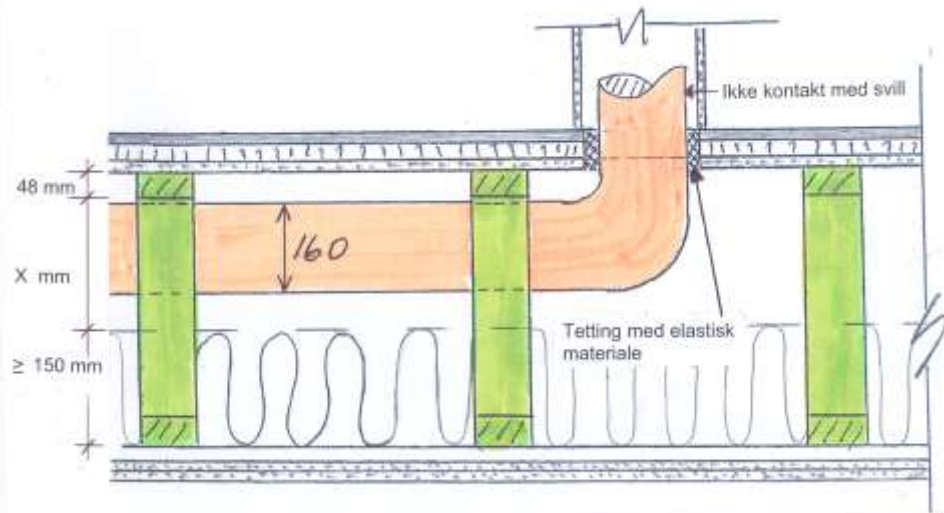
- **Similar opportunities as schools, kindergarten etc.**
 - Alternative 1 or alternative 2

Important matters for offices, schools, kindergarten & hospitals buildings

Integration of ducts

- Necessary with free transmission paths
- Necessary to fulfil fire resistance and sound insulation requirements

- **Example:**
Duct position in a floor with web joist timber beams



Important matters for offices, schools,
kindergarten & hospitals

Increased span width

- **Comfort criteria need to be fulfilled**
 - Examples and assumptions see Building detail sheet no 522.351

Beam height (mm)	Orientating span width (m)	
	c/c 300 mm	c/c 600 mm
300	4,7	4,1
400	5,7	4,9

Beam height (mm)	Orientating span width (m), c/c 600 mm	
	Without transverse stiffener	With max transverse stiffener
300	4,6	5,2
400	5,6	6,4
500	6,4	7,5

Summary of opportunities and challenges

Residential buildings

- **Challenges:**
 - **IMPORTANT** to improve low frequency impact sound insulation
 - development of stiffening structures combined with low flanking transmission
- **Opportunities:**
 - industrialized production
 - increased market share - larger buildings
 - keep the market share - smaller buildings

Summary of opportunities and challenges

Offices, schools, kindergarten & hospitals

- **Challenges:**
 - Optimization of :
 - load bearing & stiffening solutions with sound insulation, fire resistance & comfort properties
 - integration of installations
 - cost effective production & installation
- **Opportunities:**
 - increased market share
 - industrialized production