Examples of timber-frame buildings in the Netherlands

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In the presentation two different cases are discussed: (1) the high-rise apartment building Linea Nova in the city centre of Rotterdam and (2) the Maskerade® building concept for dwellings and other functions (schools, …).

In Linea Nova timber-frame floors are combined with steel main supporting structures, which is necessary because of the building’s height. During construction, vibration problems were discovered. Floor vibration levels in a dwelling due to walking in a neighbouring dwelling were annoyingly high. Also the vibration levels in the dwelling itself were annoyingly high. At that moment TNO was involved and asked to find a solution for the vibration problem. Based on measurements and FEM models, measures have been defined in order to solve the problem. The measures are (1) stiffening of the floor structures, (2) stiffening of the steel supporting structures and (3) removal of resilient mountings where possible. The measures have been applied in four mock-up dwellings and are tested at this moment.

The Maskerade® concept consists of timber-frame floor and wall structures. The building height is limited to about four storeys. Advantages of this building concept are: (1) short construction times, (2) saving of materials, (3) energy saving, (4) CO₂ neutral, (5) flexibility. During the design and testing process of the building concept the acoustic remarks and measures have been focused on airborne and impact sound insulation (specifically in the low frequency range) and on reduction of vibrations due to walking. In order to obtain enough sound insulation in the low frequency range (below 100 Hz) and to prevent vibration transmission from floor to floor due to walking some weight has been added by the application of extra (floating) floor layers on top of the original floor structure. Besides, attention has been paid on the detailing of the junctions, specifically between neighbouring dwellings.

The presentation concludes with illustrations of typical timber-frame structures applied in the Netherlands, which are placed in groups of (1) different floor structures and (2) different junctions. Several discussion aspects related to timber-frame buildings are mentioned, as a starting point for the workshop related to WP4 of the COST project.
Examples of timber-frame buildings in the Netherlands

Susanne Bron-van der Jagt et al.

design
requirements_guidelines
Sound insulation between dwellings

Airborne sound (≥ 125 Hz octave?):
Requirement $D_{nT,A,k} \geq 52$ dB(A)
Floor/wall elements: $R_A \geq 55$ dB(A)

Impact sound (≥ 125 Hz octave?):
Requirement $L_{nT,A} \leq 54$ dB(A)
Floor/wall elements: $L_{n,A} \leq 50$ dB(A)

2-5 dB difference between lab and practice included

Sound insulation within dwellings

Airborne sound (≥ 125 Hz octave?):
Requirement $D_{nT,A,k} \geq 32$ dB(A)
Floor/wall elements: $R_A \geq 35$ dB(A)

Impact sound (≥ 125 Hz octave?):
Requirement $L_{nT,A} \leq 79$ dB(A)
Floor/wall elements: $L_{n,A} \leq 75$ dB(A)

2-5 dB difference between lab and practice included
Floor vibrations due to walking between and within dwellings

- Measurements ECSC-project

<table>
<thead>
<tr>
<th></th>
<th>Heavy floors</th>
<th>Lightweight floors</th>
<th>Guideline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inside your dwelling</td>
<td>0,3-0,7</td>
<td>2-3</td>
<td>0,8-3,2</td>
</tr>
<tr>
<td>To neighbouring dwelling (estimation for good junctions)</td>
<td>0,03-0,07</td>
<td>0,2-0,3</td>
<td>0,1-0,2</td>
</tr>
</tbody>
</table>

practical guideline for floor vibrations due to walking:
ES-RMS_{95} \leq 0,8-3,2 inside your dwelling, class C-D
ES-RMS_{95} \leq 0,1-0,2 to neighbouring dwelling, class A-B

- Vibrations (due to walking, service equipment, …) determine
  - Required mass and bending stiffness of floor and main supporting structure
  - Resonance frequency mass-spring-system

Requirements

- service equipment
- rail traffic
- road traffic
- wind
- walking, jumping, dancing
- low frequency sound?
Linea Nova, Rotterdam

timber-frame floors combined with main steel supporting structures

multi-family housing and other functions in high-rise building
on top of existing warehouse in the city centre of Rotterdam
Problem

- Vibrations due to walking
- Also in neighbouring dwelling
- Unacceptably high and annoying
Investigation

- floor stiffness
- mounting plate stiffness
- girder bending and torsion stiffness
- resilient mounting stiffness
- strong coupling between girder modes, mounting, floor modes

Modelling
Results: measures

- Stiffening of girders (for torsion)
- Addition of columns in wall cavity
- Stiffening of floors in two directions
- Removal of resilience in in-dwelling mountings

Effect:
- $\text{ES-RMS}_{90} < 1.0$
- Neighbours $\text{ES-RMS}_{90} << 0.1$

Maskerade®

timber-frame floors (Kerto®, Finnforest; Flexvloer®) and walls

single-family housing,
multi-family housing up to 4 storeys,
buildings with multiple functions,
on several locations in NL
Het Masker, Veenendaal

Multi-family housing, Buren
Discussion (1)

- heavy or lightweight floating floor?
- extra mass?
- number and type of connections between floor-wall and walls?
- resilient mountings?
categories of structures

discussion points for workshop WG4

Classification aspects

- heavy or lightweight floating floor?
- extra mass?
- type of junction?
- ceiling?
- type of floor structure?
- number and type of connections between floor-wall and walls?
- resilient mountings?
Discussion aspects for workshop WG4

- Different floor (supporting) structures
  - Massive wood (Finnforest, Lenotec) or “canal plates” (Lignatur)
  - Laminated wood, floors with ribs (Finnforest, Kerto; Flexvloer®)

- Extra layers
  - Combinations with concrete/anhydrite/cement layers directly on wooden floor plate or beams
  - Application of floating floors: heavy – lightweight
  - Ceilings

- Combinations with other materials
  - i.e. steel for main supporting structures (high-rise buildings)

- Different junctions
  - Completely separated (horizontal, vertical?)
  - Party coupled
  - Coupled by resilient mountings (how?)

- Function of the building and corresponding sound and vibration insulation criteria