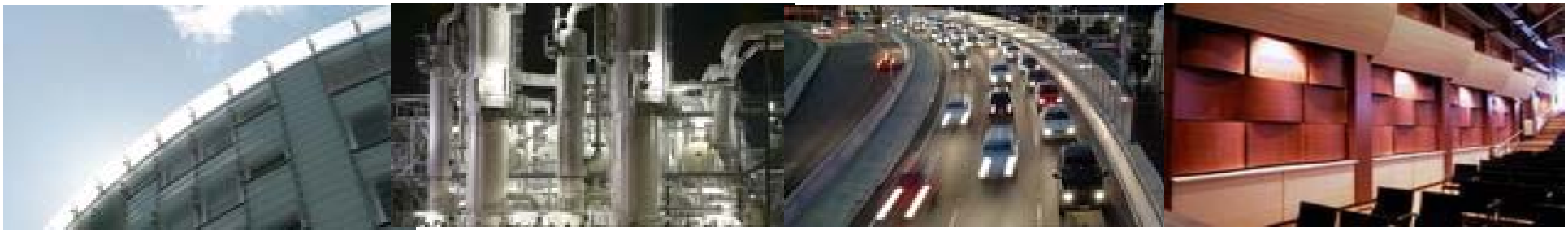
Rak-43.3415 Building Physics Design 2
ACOUSTICAL DESIGN
Autumn 2015



LECTURE 3, part 2
Changes of use
(Käyttötarkoituksen muutokset)

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HELIMAKI ACOUSTICS

Change of use (Käyttötarkoituksen muutos)

- A *change of use* occurs when the original use of the space changes as the result of renovation (i.e. old attic converted to apartments)
- Requires building permit and/or a change in city plan
- The statement of the Finnish Ministry of the Environment regarding changes of use:
  - Current sound insulation regulations must be fulfilled
  - If the use of the space does not change regulations need not be fulfilled; however, the renovation must not deteriorate the current sound insulation level

Application of regulations

- Local building control authoritatives determine the regulation level to be applied to the project
- The extent to which Building Codes apply is considered based on the nature and extent of renovation as well as the use of the space to be renovated
- The special characteristics of the building and applicability to the intended use need to be considered
- Usually the goal is to fulfill current regulation level, some mitigation can be given concerning e.g.
  - Impact sound insulation of stairways
  - Airborne sound insulation requirements of stairway doors

Change of use – acoustical challenges
Difference to new construction

- The greatest challenges in the acoustical design of dwellings are associated with changes of use
- The difference to new construction:
  - New construction uses standard solutions with well-known properties
  - In renovation there are no standard solutions, which means that the acoustician needs to check all the structures
- Sound insulation – the problem solving process:
  1. Find out all the possible paths of sound between spaces
  2. Find out the sound insulation along these paths
  3. Determine structures, sealing details, silencers etc. with which to improve sound insulation to required level

Change of use – acoustical challenges
Phenomena to be considered

- Airborne sound insulation
  - Horisontal direction
  - Vertical direction
  - Effect of HVAC installations (ducts etc.) on sound insulation
- Impact sound insulation
  - Horisontal direction
  - Vertical direction
- Sound insulation of the facades and roof
- HVAC noise control

Starting points for design

Example: conversion of attic to apartment

- Specific consideration in attic conversions: the effect of the renovation on the acoustical conditions in the former top floor
- Usually the sound insulation of the floor between the attic and the top floor is inadequate (both airborne and impact sound insulation)
- Usually it is not possible to make changes to the roof of the former top floor, thus all the improvements need to be done in the attic:
  - Impact sound insulation vertically
  - Vertical sound insulation vertically
- The load bearing capacity of the old floor sets limitations to acoustical design

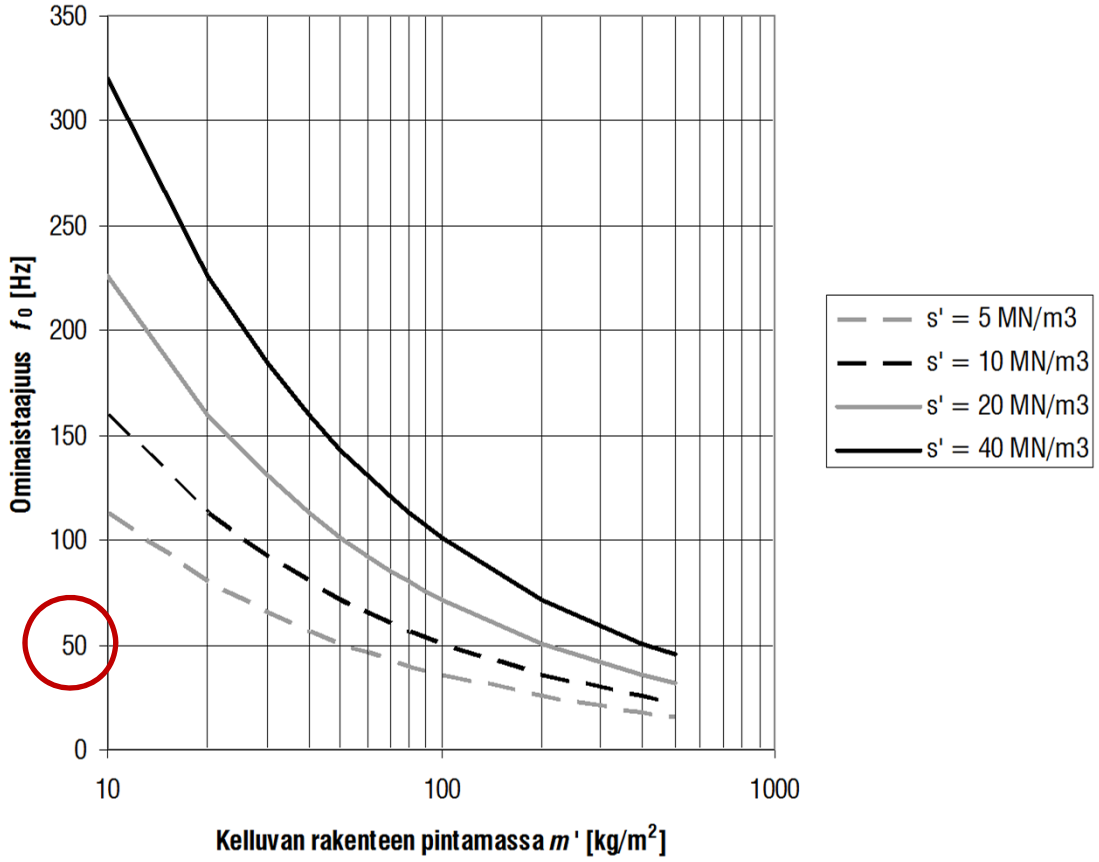
Design principles
General issues

- The resonance frequency of the floating floor must be designed to be below 50 Hz in order to achieve subjectively good impact sound insulation

  → The floating structure needs to be as heavy as possible, e.g. concrete slab > 60 mm (limitations to design: load bearing capacity of the old floor, maximum allowable height of the floor, costs)

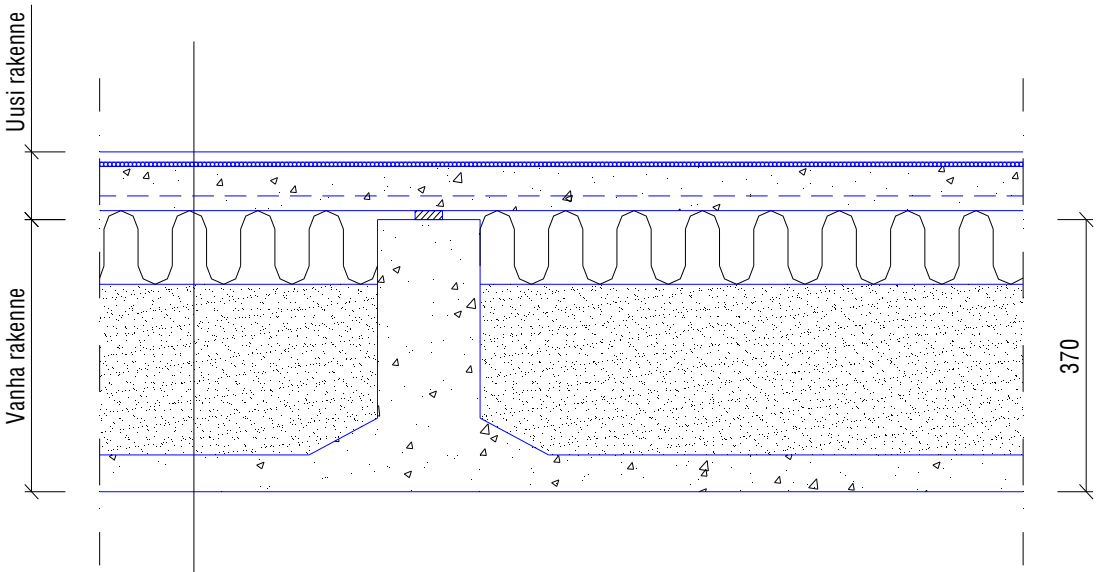
  → The insulation material needs be flexible (low dynamic stiffness), e.g. Paroc SSB1 50 mm, dynamic stiffnes $s' = 8$ MN/m^3
- Other possibility is to design the floating floor using vibration isolation material (e.g. Sylomer); the vibration isolators are installed e.g. on the old floor joists as strips and the new floor is constructed on top
  - The design of the vibration isolators depends on, e.g., the center-to-center spacing of the old joists
- Flanking transmission via the floating floor structure needs to be considered (horisontal sound insulation between neighbouring attic apartments)

Design principles
Resonance frequency of floating floor



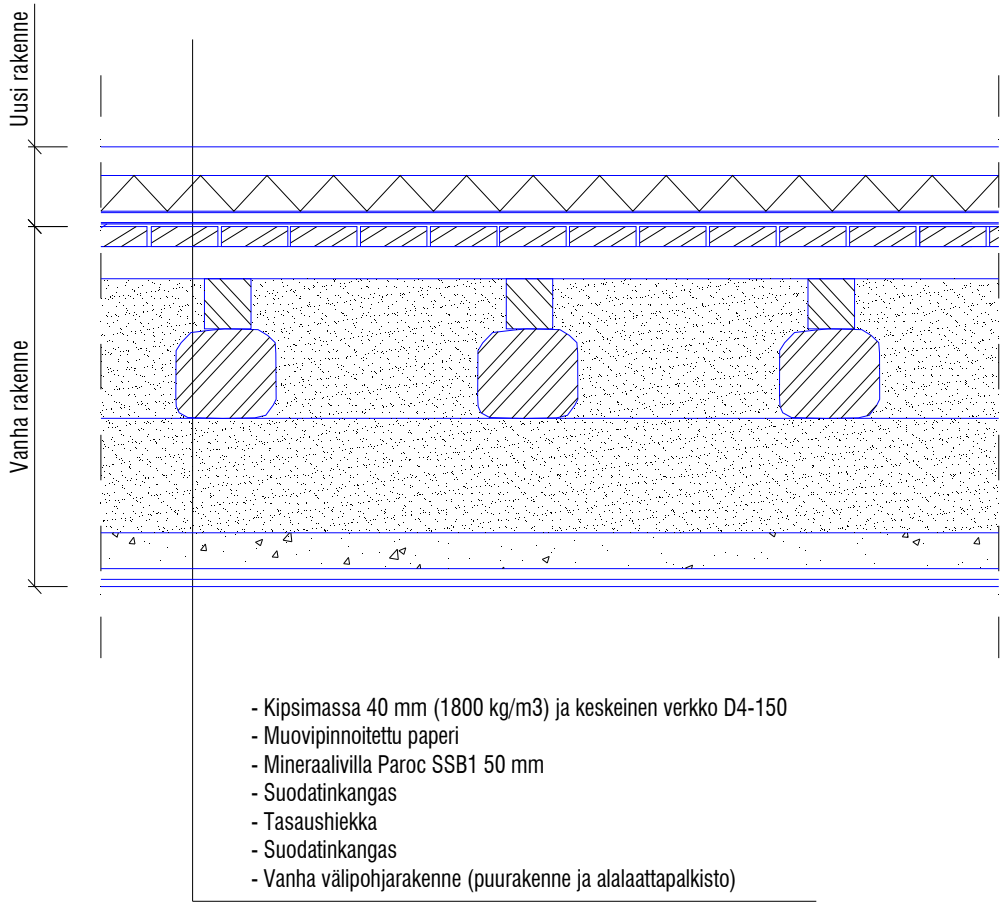
Design principles

Example 1: concrete slab on vibration isolators



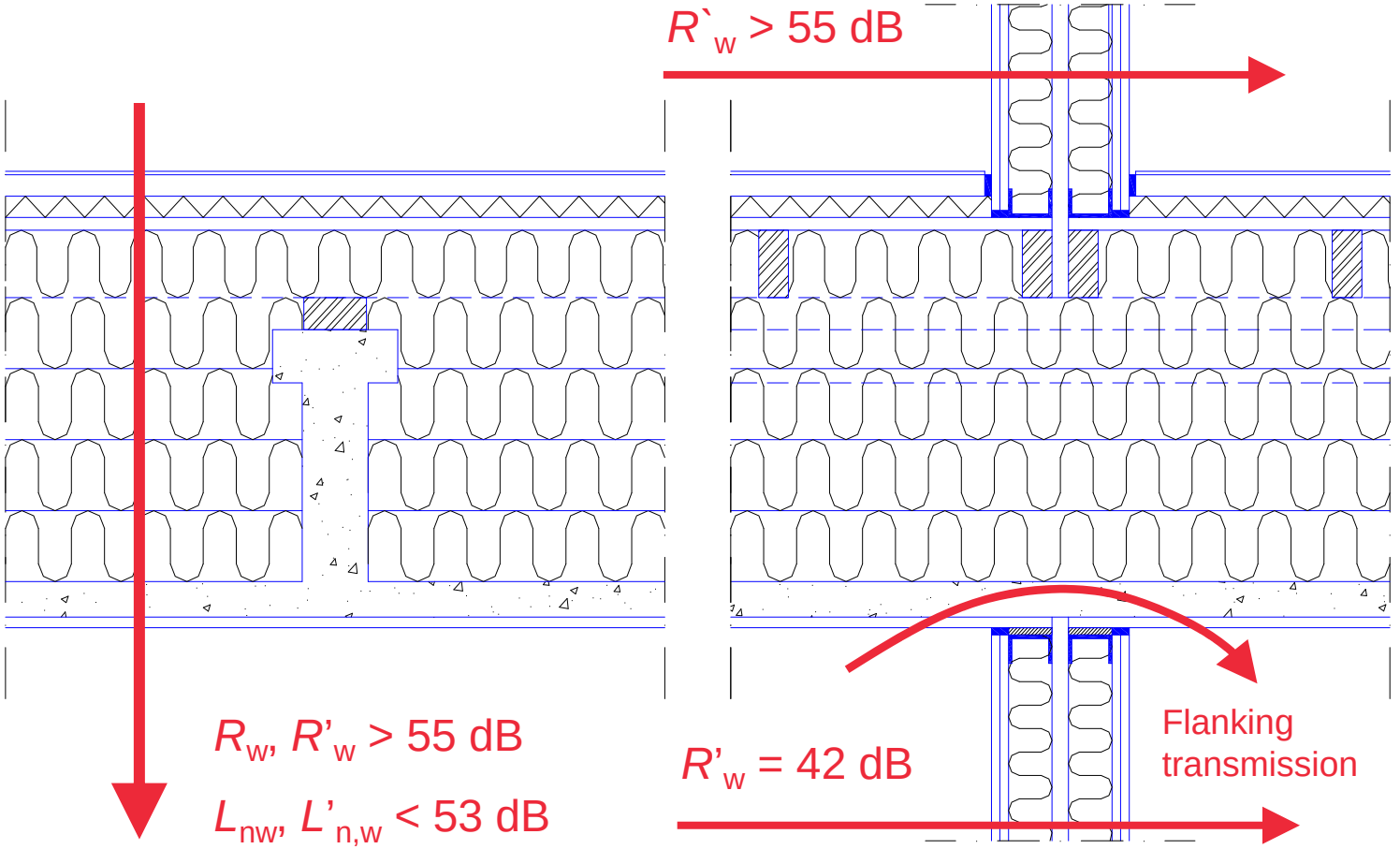
- Lautaparketti
- Parketinalusmateriaali Tuplex
- Betonilaatta 60 mm, muottina poimulevy
- Palkkien päällä Sylomer-kaista P12, leveys 40 mm k 1100
- Mineraalivilla 100 mm
- Vanha alalaattapalkisto, korkeus 370 mm
  - palkit k 1100
  - alalaatta noin 40-50 mm
  - palkkien välissä vanha täyte

Design principles
Example 2: floating floor

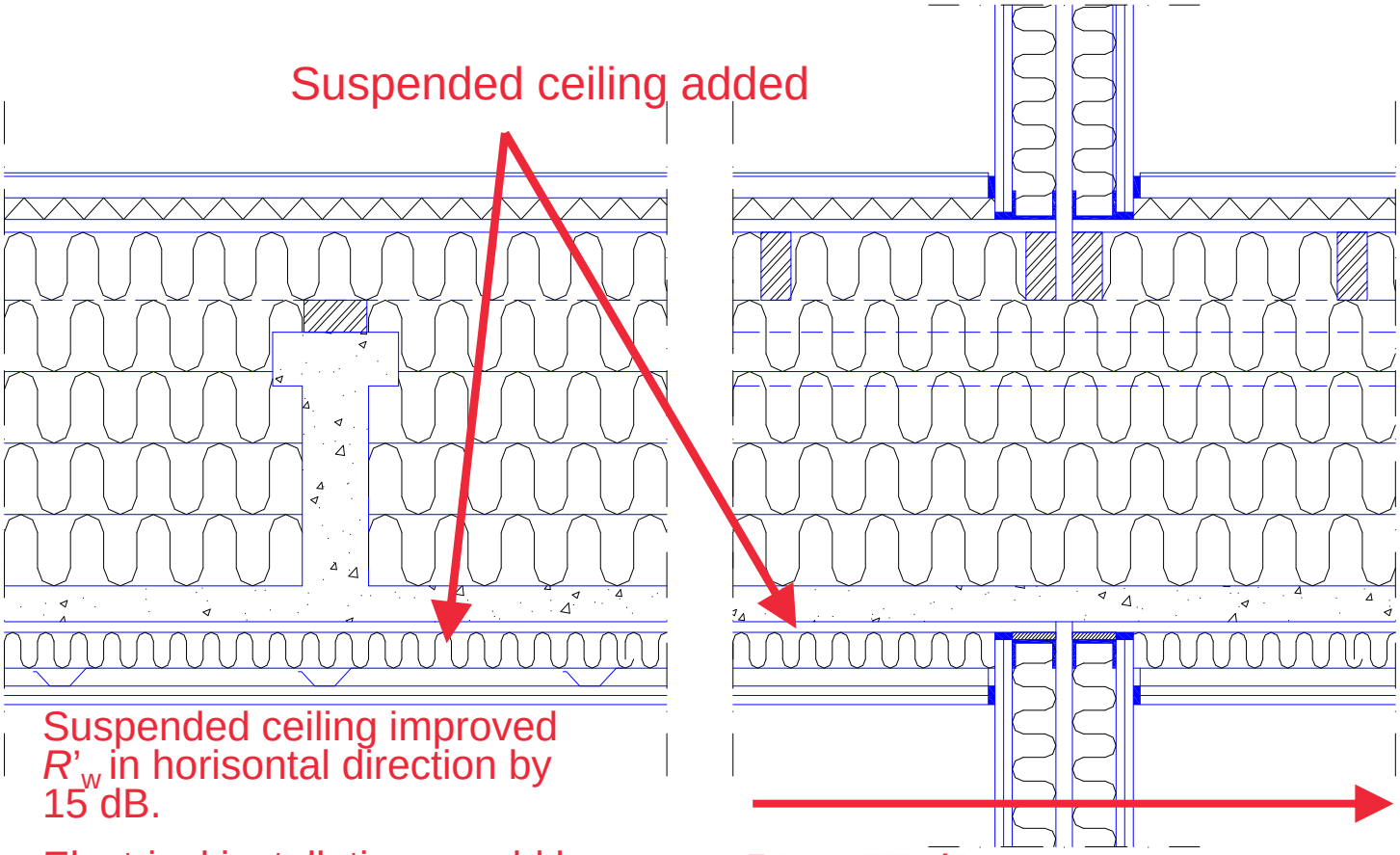


- Kipsimassa 40 mm (1800 kg/m3) ja keskeinen verkko D4-150
- Muovipinnoitettu paperi
- Mineraalivilla Paroc SSB1 50 mm
- Suodatinkangas
- Tasaushiekka
- Suodatinkangas
- Vanha välipohjarakenne (puurakenne ja alalaattapalkisto)

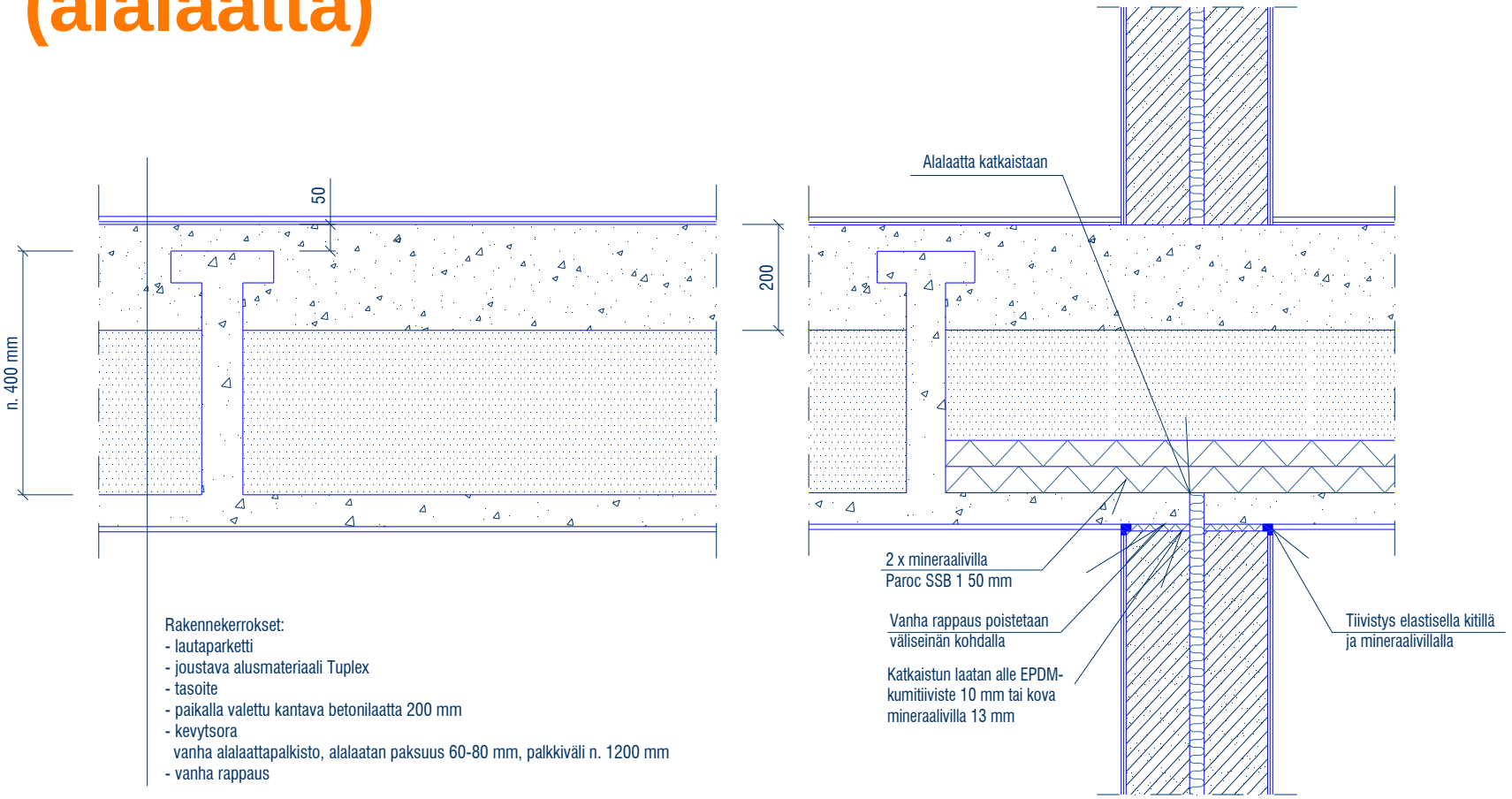
Example: flanking transmission



Example: flanking transmission



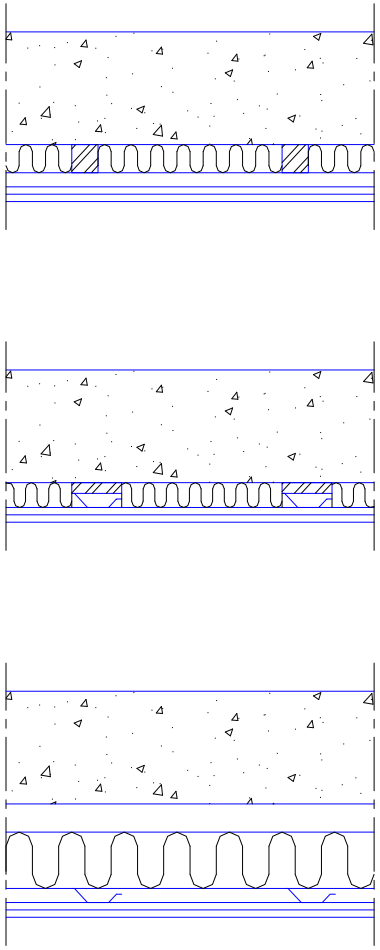
Example: preserving old inverted beam (alalaatta)



Rakennekerrokset:
- lautaparketti
- joustava alusmateriaali Tuplex
- tasoite
- paikalla valettu kantava betonilaatta 200 mm
- kevytsora
  vanha alalaattapalkisto, alalaatan paksuus 60-80 mm, palkkiväli n. 1200 mm
- vanha rappaus

Examples of lightweight wall claddings

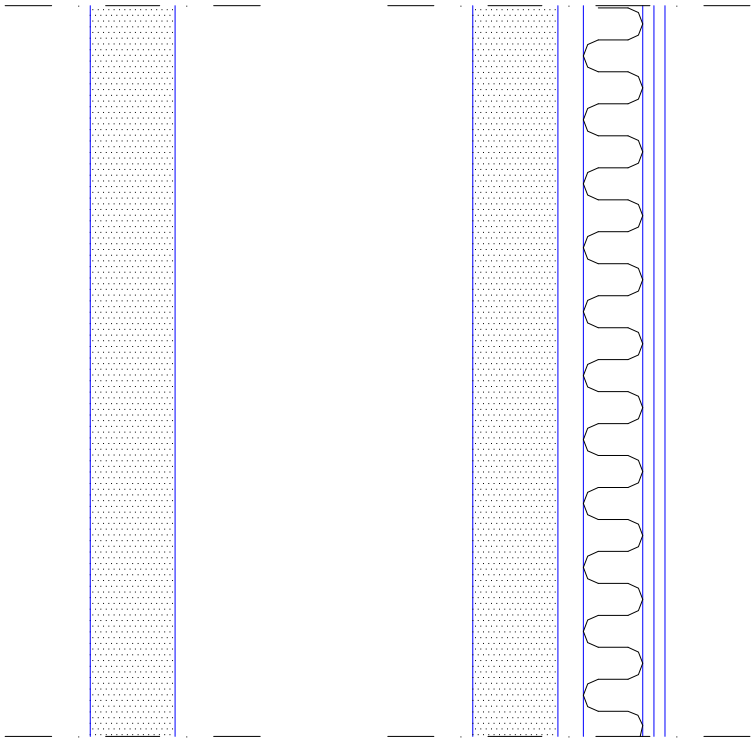
- Use of lightweight claddings:
  - Improve structures with poor sound insulation
  - Decrease flanking transmission between spaces
- Usually all lightweight masonry structures need to be cladded (or truncated) when they extend continuously from room to room
- The amount of plates and thickness and filling of the airspace depends on the needed level of improvement

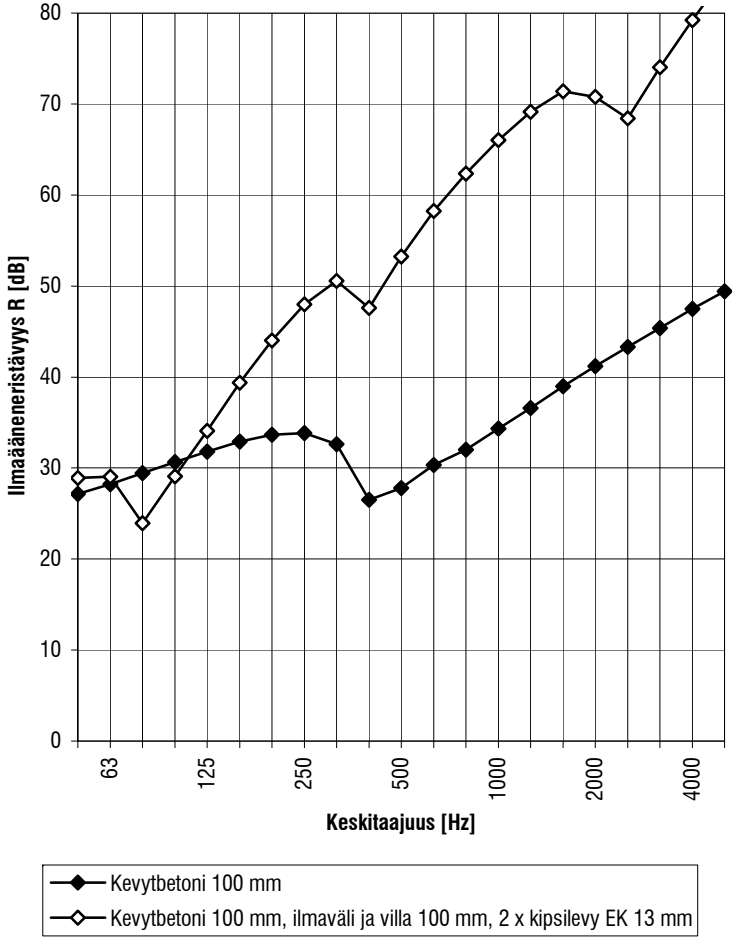


Improving effect of wall claddings

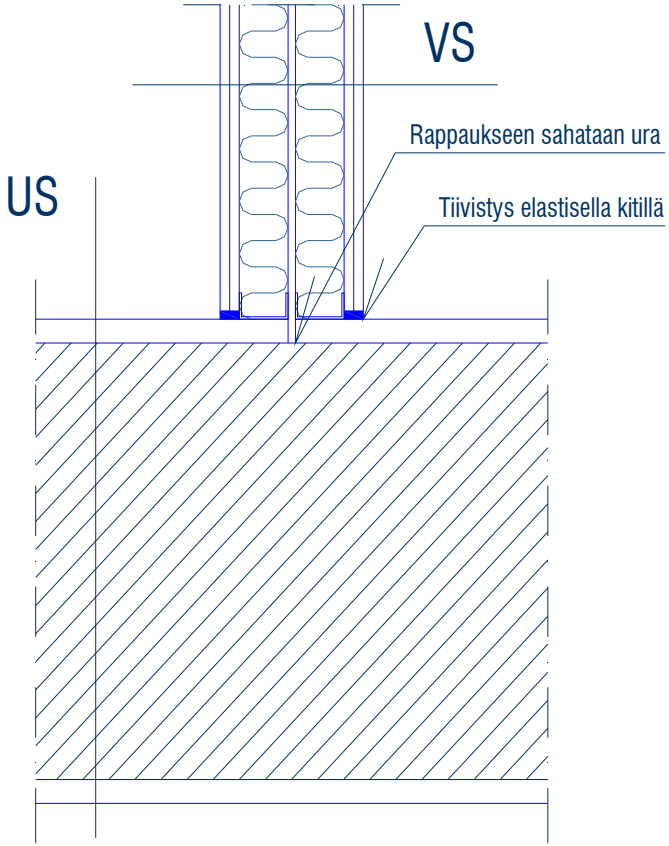
R_w = 35 dB

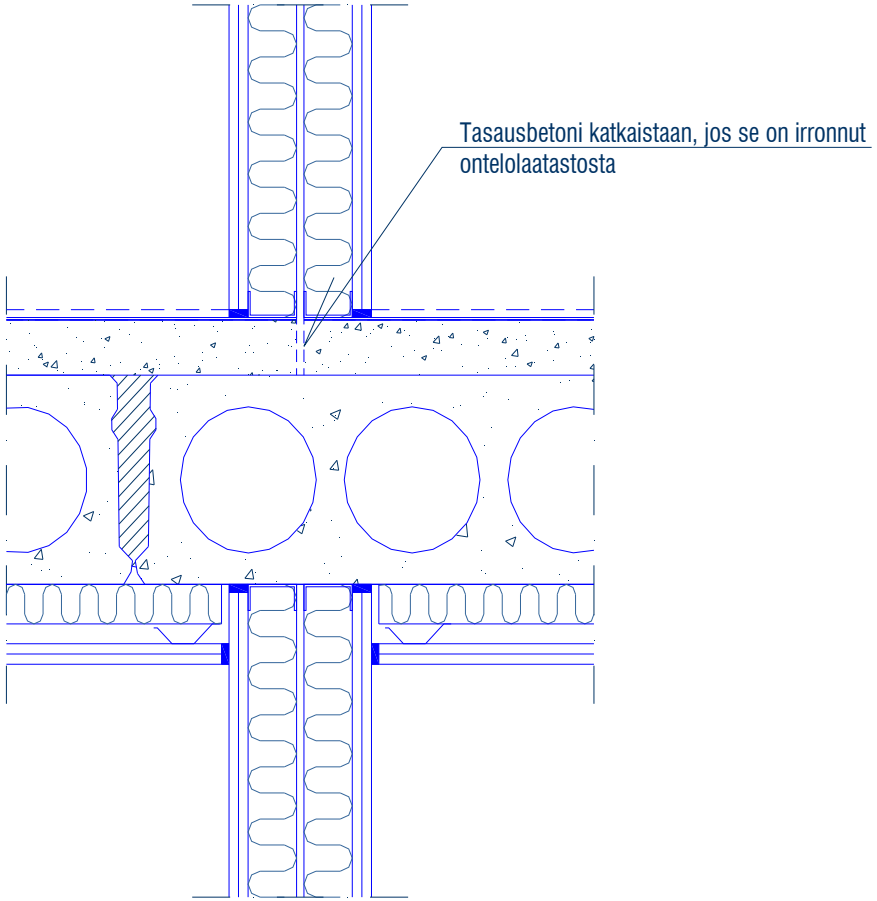
R_w = 55 dB





Other flanking paths

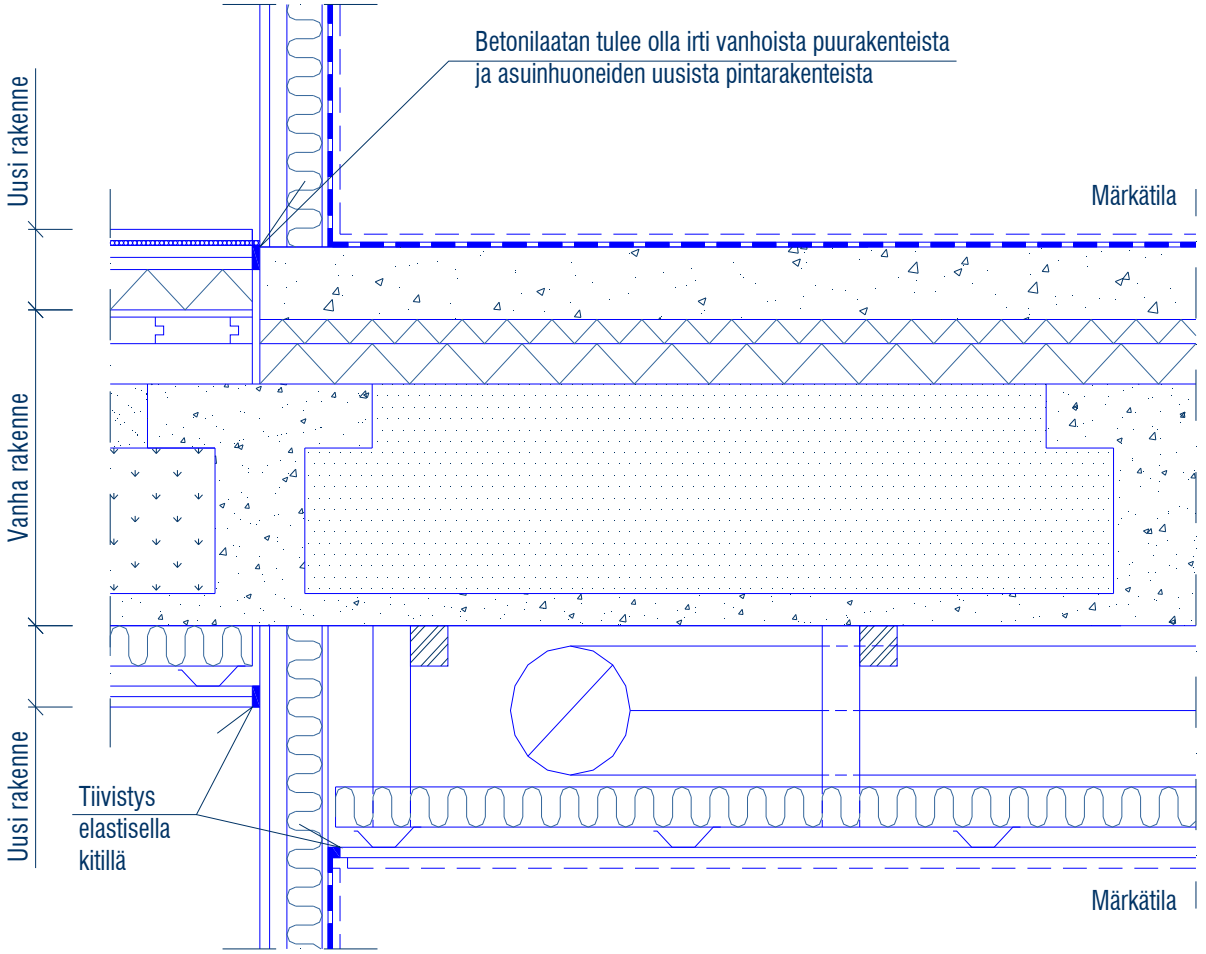




Impact sound insulation of stairs

- Starting point:
  - Stairs and levels rigidly fixed to building frame → $L'_{n,w}$ typically about 70 dB
- Solution 1:
  - Add flexible floor covering to stairs, storey and intermediate landings
  - Floating floor construction may be used on the landings
- Solution 2:
  - Suspended ceiling and floating floor in apartments
  - Cladding on the wall facing the stairway

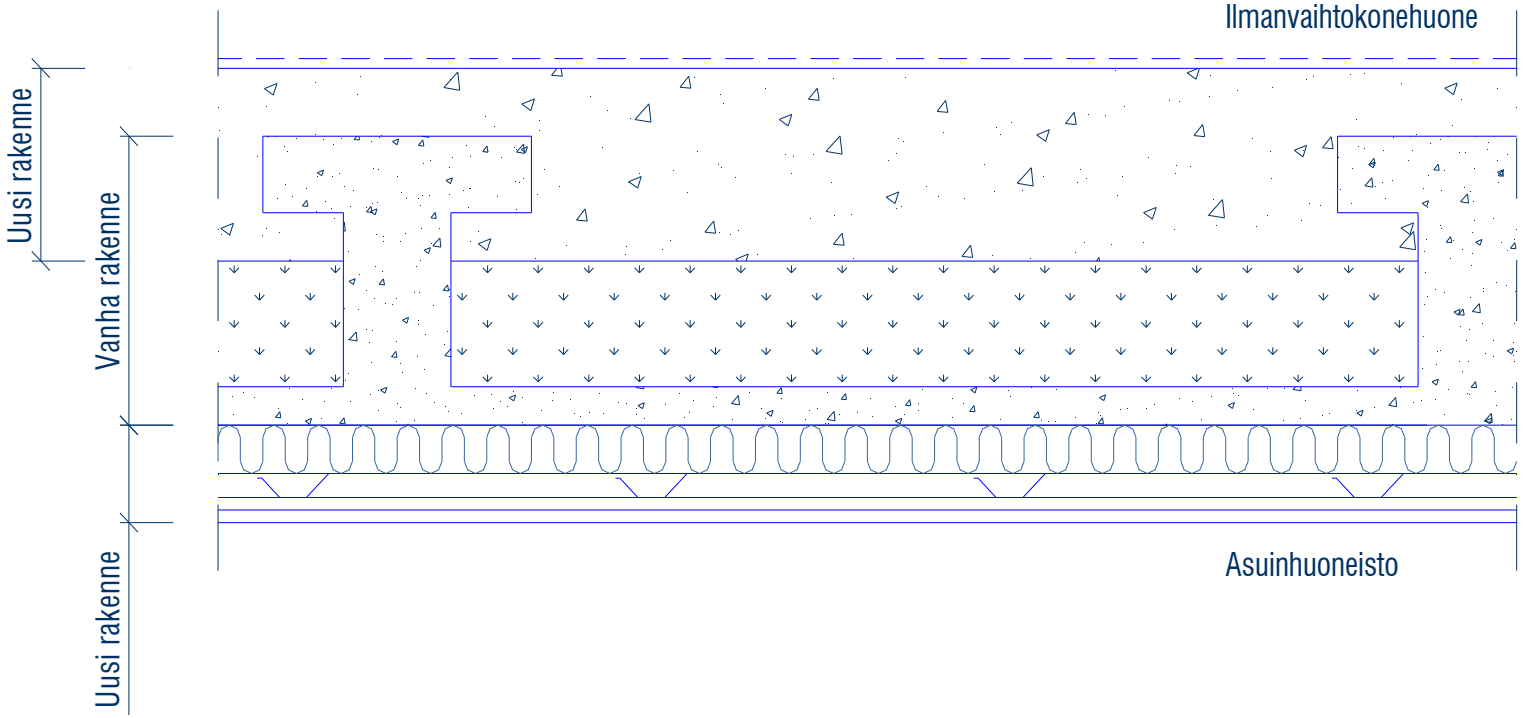
Bathrooms etc.



HVAC noise control
Principles

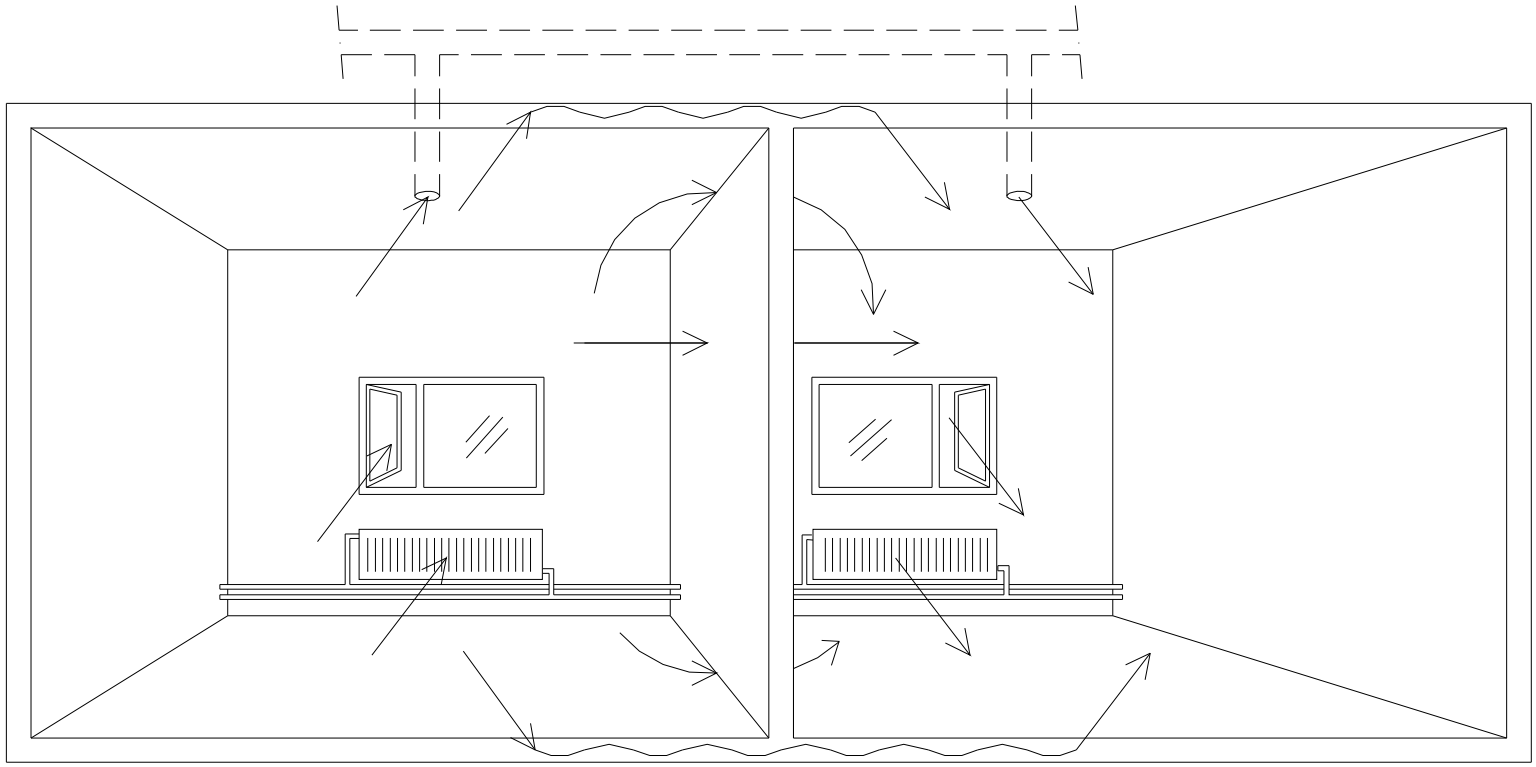
- HVAC design in changes of use doen not differ from new construction
  - Thick and rigid concrete slab (> 200 mm) to HVAC machinery room
  - Silencers to ducts going from apartment to apartment
- Water and heating systems are designed as in new construction
- Sewer system can only be implemented as so-called irti-system (a system where the pipes are vibration isolated from the building frame, more on this in lecture 5...)

HVAC noise control
Floor of ventilation machinery room



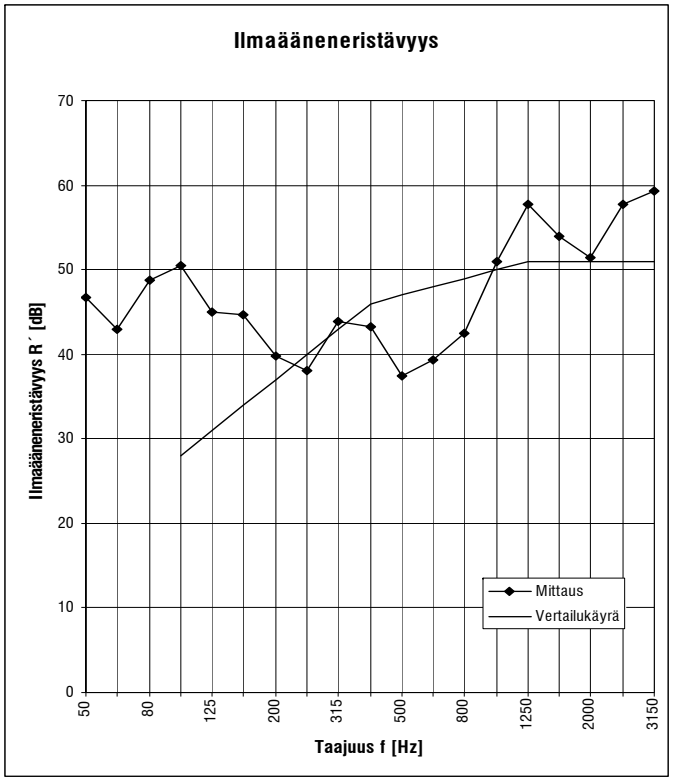
No floating floor to ventilation machinery room!

HVAC noise control
Flanking via ventilation duct



HVAC noise control
Example of flanking via ventilation duct

No silencer: $R`_w$ = 47 dB



Duct opening taped: $R`_w$ = 59 dB