1.1 Novel Solution #4 – High performance insulation of floors (Alingsås pilot)

Novel solution applied in the Alingsås pilot

1.1.1 Location in building – Alingsås

Figure 1 below shows where in the building this Novel Solution is applied.

Figure 1 Location in building. Only ground floors within flats are affected by this solution

1.1.2 Existing Construction

Original construction of bottom floors in flats, top to bottom (mm):

- Flooring
- 50 concrete
- 60 sand
- 30 mineral wool
- 80-250 structural concrete *
- 150 drainage layer (gravel)

*) Depending on foundation and load bearing structures (slab on ground, piled or strip foundation). There are no suspended floors in the area, all bottom floors connect directly to the ground.

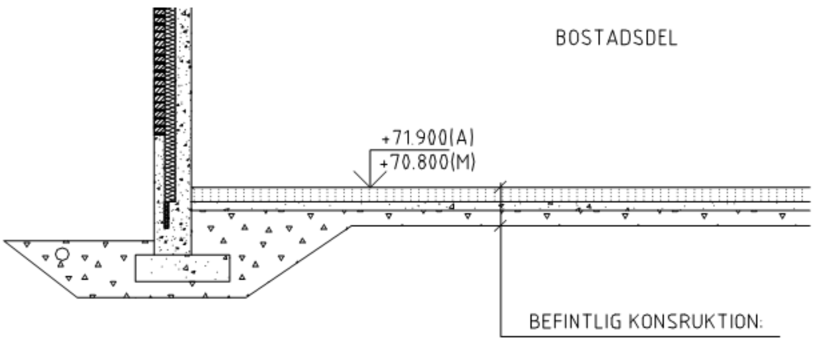

Figure 2 Original construction of floor in Alingsås bottom floor flats

1.1.3 Identified Problems

Regarding the flats in their original state, some complaints on cold draughts and poor thermal comfort might originate from the floors that were not very well insulated. However, the discrepancy in insulation rates after retrofitting has been a more important issue.

The important aspect about bottom floors compared to other parts of the building envelope, like roof and exterior walls, is that it's very hard to address slab-on-ground-floors with exterior supplementary insulation measures. AT the same time, interior insulation is restricted by the room height and might increase the risk of moisture transport due to colder structures. Different conventional measures have been tried in Alingsås but the performance has not been good enough, since the insulation capacity has been inadequate. Hence, after retrofit the bottom floors turn out to be the weakest point of the building in terms of heat insulation, including heat losses through footings and grounds.

All in all, the problems specifically related to bottom floors are:

- A substantial part of heat transmission losses passes through the floor constructions, affecting the energy performance of bottom floor flats in particular
- Thermal comfort and interior temperatures of bottom floor flats are affected. Measures are therefore to be focused to flats, not to common areas such as stairwells or basement floors, as dwellings have higher demands in terms of space heating and comfort
- Exterior supplementary insulation is not possible in existing slab-on-ground-buildings, and interior insulation must not affect the room height

1.1.4 Solution

The key to interior insulation was to find a high performing insulation material with a λ value low enough to give good insulation even in thinner layers. To maintain an efficient construction process and keep the room height, the floor level before and after needed to be the same. This was solved with the following construction, where the original top layers were replaced by 80mm of high performing PIR (polyisocyanurate) insulation.

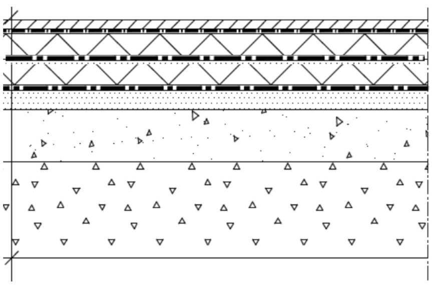

Figure 3 Structural layers of new floor

- Flooring (including sound insulation)
- 0.2 PE-foil (air and moisture tight layer)
- 40mm of PIR (original λ value 0.023 W/m/K)
- 0.2 PE-foil (to avoid squeaking noises)
- 40mm of PIR (original λ value 0.023 W/m/K)
- 0.2 PE-foil (protecting aluminium from concrete)
- Levelling concrete
- 80-250 Existing structural concrete
- 150 Existing drainage layer

The additional space for insulation is created by removal of the sand filling and top layer of concrete of the original bottom floor structure, leaving a fairly uneven structural concrete surface for application of insulation. Levelling concrete evens out the surfaces in a quick and rational way, and helps air tightening the concrete structures. However, moisture content is an important aspect that needs to be controlled regarding both bottom floor and levelling concrete.

The aluminium facing of the PIR boards prevents the loss of insulation capacity through emissions, but needs to be protected from the high pH of the concrete, hence the plastic foil. The boards are rigid and easy to handle, not as flexible to impact as EPS boards

Experiences show no moisture transport or impact on concrete walls in flats due to the colder concrete floor below. The interior insulation process using rigid boards is quick and clean.

Figure 4 Assembly of PIR insulation as floating floor structure. Mounting of first layer on plastic foil (left) and covering second layer with another sheet of plastic foil (right).

1.1.5 Energy Experiences

The PIR floor gave the best possible thermal performance at the current conditions, interior application and restricted dimensions. In addition to this, earlier attempts with cellular concrete or rebuilt floors (where possible) struggled with inefficient processes and a bad workability. The resulting U-value for the bottom floor as a whole in a slab on ground building, including dwelling and storage areas and thermal bridges, was found to be 0.17 W/m²/K. It is hard to meet passive house standards of a U-value around 0.1 W/m²/K, but the solution addresses thermal performance in bottom floor flats better than the alternatives studied.

PIR is an extruded cellular plastic that holds a lower λ-value due to properties of the blowing agent of the material that substitute the air compound of the material. However, the original λ value of the material (0.023 W/m/K) rises a little during the first 20 years due to gas diffusion substituting some of the blowing agent with air, rendering a final λ-value to 0.026-0.028 W/m/K.

For the Alingsås case, calculations show that a PIR application is superior to EPS and graphite enhanced EPS in terms of effect on heat losses and thus thermal comfort. However, from a cost perspective, graphite-EPS is much more effective.

1.1.6 Lessons Learnt

To see to the bottom floors in holistic retrofitting is very important, since the significantly poorer thermal performance of the bottom floor otherwise might have a great influence on the energy losses and thermal comfort of bottom floor flats after retrofit. Experiences from the Alingsås project show that high performance insulation is needed in order to address the need for insulation interiorly without affecting the room height, door openings and alike. The final design and assembling methodology was developed by the team of designers, material expertise and personnel on site.

Interior insulation using PIR Boards in a floating floor is assessed to have a large market potential in retrofitting. The assembly is rational and efficient, and the high performance insulation enables a satisfying insulation even where the available space is limited.

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