EuroPHit

D5.1.16_Guidelines_Internal Insulation

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[Improving the energy performance of step-by-step refurbishment and integration of renewable energies]

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Abstract

The energy-relevant refurbishment of existing building stock requires approaches using insulation on the inside, especially in the case of listed historical buildings. The influence of these constructions should be evaluated in terms of building physics. The hygrothermal behaviour of the interior insulation systems cannot be considered in isolation as is done for exterior insulation systems; rather, it is closely related to the material characteristics of the existing wall, the local climatic conditions and utilisation. The increased moisture content of the existing wall due to interior insulation involves the risk of damage, which needs to be assessed. The following criteria are intended to provide valuable tips and guidance for assessment.

The guidelines for internal insulation are focused on two main features of the assessment. First, the planning of the construction solutions to prevent moisture accumulation in or behind the insulation. And, second, the examination of the solutions to evaluate possible damage of the structure, in order to guarantee that the durability of the structure is not decreased, and there are no adverse health effects caused by the addition of the interior insulation. The final section of the document includes a checklist of considerations for planning internal insulation in a step-by-step retrofit.

1 Introduction

The use of Passive House components in the refurbishment of existing buildings results in extensive improvements with reference to thermal comfort, cost-effectiveness, structural integrity and climate protection. A 90 % reduction in the heating demand has now been achieved in a number of projects. Nevertheless, achieving the Passive House Standard in modernisations of existing buildings is not always a realistic goal - among other things - due to the fact that after the refurbishment, unavoidable thermal bridges remain for example in the form of basement walls.

The Passive House Institute has developed the certification "EnerPHit - certified modernisation using Passive House components". This specifies either a maximum heating demand of 25 kWh/(m²a) or alternatively the consistent use of Passive House components in accordance with the requirements for building component certification set out by the PHI. The heating demand calculated using the PHPP and the quality of thermal protection of the individual building components are stated on the certificate.

Building refurbishments with interior insulation can be certified with the EnerPHit+i Seal.

The energy-efficient refurbishment of historical buildings under preservation orders poses a particular challenge as this requires bringing into accordance the comfort demand of users and the maximum possible reduction of energy consumption with the preservation of the original historical building substance. Numerous examples of energy-efficient refurbishments of existing buildings using interior insulation have demonstrated, and continue to demonstrate, that these objectives are not mutually exclusive. Scepticism towards interior insulation discourages or prevents a high quality of urgently needed and desirable energy-efficient refurbishment of existing buildings. This stems from the damage caused in most cases, which were all due to incorrect execution.

The energy-relevant refurbishment of existing building stock requires approaches using insulation on the inside, especially in the case of listed historical buildings. The influence of these constructions should be evaluated in terms of building physics within the framework of EnerPHit building certification. The hygrothermal behaviour of the interior insulation systems cannot be considered in isolation as is done for exterior insulation systems; rather, it is closely related to the material characteristics of the existing wall, the local climatic conditions and utilisation. The increased moisture content of the existing wall due to interior insulation involves the risk of damage, which needs to be assessed. The following criteria are intended to provide valuable tips and guidance for assessment.

2 Assessment of internal insulation

Within the framework of building certification, comprehensive planning and documentation should be carried out for the interior insulation measure. This should include information about the existing situation, the system properties of the interior insulation and a concept for airtightness.

1.1 Planning requirements for interior insulation

Gap-free and meticulous execution of the airtight layer is especially important in refurbishment measures involving interior insulation. Non-airtight connections, faulty execution and systemic weaknesses will lead to moisture accumulation in or behind the insulation layer and considerably increase the risk of structural damage (see Figure 1). While the skilled trades are responsible for careful execution of the work, practical solutions which can be implemented for situations specific to existing buildings must be provided by the planners and system suppliers. In the concept for refurbishment, typical penetrations and connections must be taken into account and systemic weaknesses (e.g. the possibility of air currents behind the insulation layer) must be avoided.

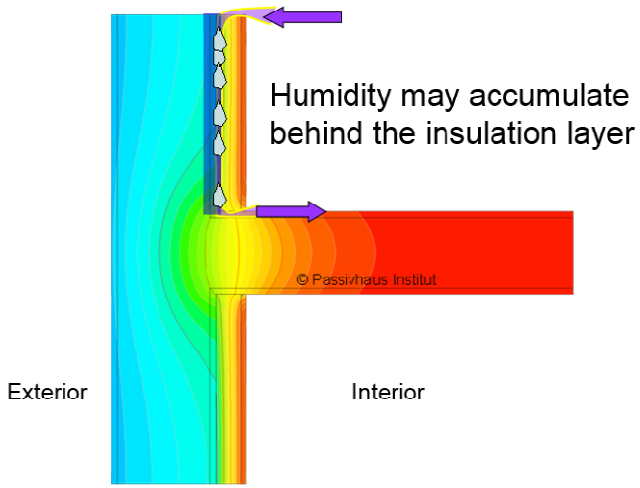
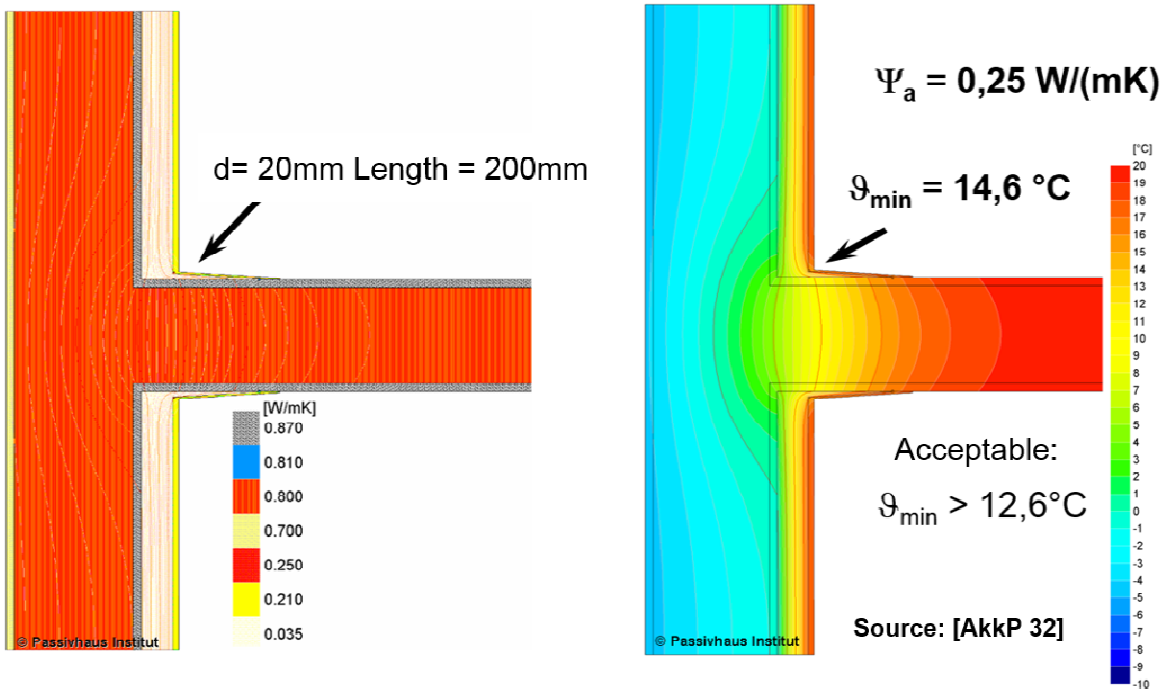


Figure 1 Faulty execution of interior insulation may lead to moisture problems and increased risk of structural damage.

In the context of planning for interior insulation systems, constructive solutions should be developed for thermal bridge optimised and airtight connection of the insulation system with intersecting walls and ceilings and at reveals. In doing so, the following general rules for planning must be kept in mind:

- Use of flanking insulation or guide plates for intersecting interior walls increases the surface temperature and reduces the risk of structural damage (see Figure 2).
- Insulation of the reveals near the windows is absolutely essential for ensuring a sufficiently high interior surface temperature.



In this case, a "wedge" in the intersection between the wall and the slab allows for a higher surface temperature, reducing the risk of mold formation and/or structural damage.

Figure 2 Example of connection between slab and wall with internal insulation

Interior plaster in old buildings is usually uneven. If interior insulation in the form of panels (EPS, foam glass or calcium silicate) is used, hollow spaces may easily result behind the insulation layer. Mould growth will occur if these hollow spaces are connected even minimally with indoor air, e.g. through tiny leaks. This risk can be eliminated either by levelling out any unevenness in advance, or by applying adhesive all over the surface of the insulation panels.

The following solutions must be presented:

- Clear, unambiguous identification of the airtight layer e.g. new interior plaster or vapour retarder
- Description of the airtight connection at intersections e.g. adhesive tape
- Sealing of the airtight layer with windows, doors, ceilings (particularly wood beam ceilings) and intersecting walls

1.2 Examination concerning damage due to interior insulation systems

Verification must be provided regarding the absence of damage due to interior insulation based on the heat and moisture-related characteristics of the existing masonry as well as the interior insulation system and the climate boundary conditions prevailing in the location.

Dynamic simulations of the coupled heat and moisture transport are strongly recommended if:

- Capillary active insulation materials are used, or
- if protection from driving rain has not been defined (e.g. in case of brickwork, for determining the hydrophobisation characteristics)

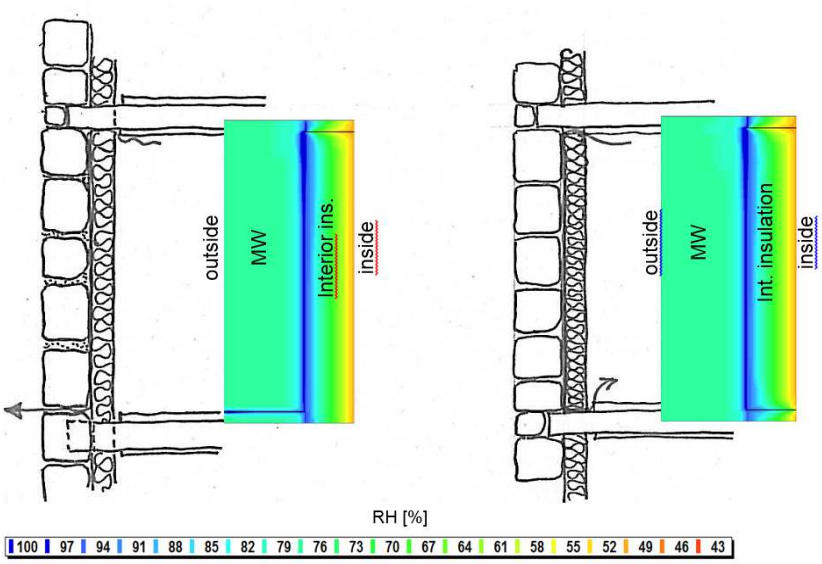


Figure 2. Examples of examination.
Extended leakage path in contact with the outside air (left) and air flow behind the insulation in contact on ly with indoor air (right)

This dynamic simulation will provide comprehensive information about the hygrothermal processes occurring within a building component and is therefore very suitable for analysing the functional reliability and durability of constructions. A range of criteria which allow assessment of the risk of structural damage have been compiled below. The prerequisite for positive evaluation of a construction are given if:

- durability is not decreased by the insulation measure
- no adverse health effects due to the measure are expected or if interior insulation improves a construction that was previously critical.

These criteria are conformed if:

- no moisture accumulation occurs
- the moisture content of the materials is below a critical limit
- the moisture content of wood or wood-based materials is below 20 and 15 mass percent [DIN 68800-2]. Its annual fluctuation range is also limited to 3 mass percentage points
- the risk of mould growth is low

3 Checklist: planning internal insulation

Structural condition of the existing construction

- rising damp and cracks in the masonry must be remedied
- examination of joints in exposed masonry walls, if necessary these should be repaired or renewed
- renewal or removal of the old interior plaster can be dispensed with if it is continuously and firmly joined with the brickwork, and if it is clean and has a homogeneous surface
- Wallpaper, glue or adhesive residues or vapour reducing paint has to be removed

Characteristic values of materials

- Feasible assessment of characteristic values of materials
- Reference tables, such as the [DIN EN ISO 10456] "Building materials and products - Hygrothermal properties - Tabulated design values", the DIN 4108-4 "Thermal insulation and energy economy in buildings - Part 4: Hygrothermal design values", or the material properties database for energy efficient refurbishment of existing buildings [MASEA] are used as an aid
- Masonry walls do not provide any useful indications of their hygric behaviour, so that based on current knowledge, a laboratory analysis of the brick constitutes an advisable approach. Statements regarding the suitability of an insulation system for exposed masonry walls can therefore only be made in conjunction with measured results

Planning requirements

- Gap-free and meticulous execution of the airtight layer is especially important in refurbishment measures involving interior insulation. The planning has to include:
  - Clear, unambiguous identification of the airtight layer e.g. new interior plaster or vapour retarder
  - Description of the airtight connection at intersections e.g. adhesive tape
  - Sealing of the airtight layer with windows, doors, ceilings (particularly wood beam ceilings) and intersecting walls
- Avoidance of thermal bridges
  - Use of flanking insulation or guide plates for intersecting interior walls increases the surface temperature and reduces the risk of structural damage
  - Insulation of the reveals near the windows is absolutely essential for ensuring a sufficiently high interior surface temperature
  - The planning has to include a description of fixation of the interior insulation (substructure or wall-plug) and an assessment of their influence
  - For certification as an EnerPHit refurbishment project the criteria $U \leq 0{,}35$ W/(m²K) for outer walls with internal insulation has to be achieved

- for wood beam ceilings following measures are advisable:
  - Exposing the beam near the exterior wall
  - Filling any hollow spaces between the beams and wall area
  - Cleaning the beams and filling any cracks
  - Preliminary treatment of the beam using a suitable primer
  - Creating an airtight seal with the sheeting

Assessment of proof for preservation of structures
• A dynamic simulation will provide comprehensive information about the hygrothermal processes occurring within a building component and is therefore very suitable for analysing the functional reliability and durability of constructions • Following criteria have to be fulfilled: ▪ No decreasing of durability • no moisture accumulation occurs • the moisture content of the materials is below their critical limit • The moisture content of wood or wood-based materials is below 20 and 15 mass percent [DIN 68800-2]. Its annual fluctuation range is also limited to 3 mass percentage points • A low risk of mould growth