Patrycja Kochaniuk, July 2012
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Suspended timber floor insulation

The U-value of the uninsulated and unsealed suspended timber floor in a case study house (Fig. 1) is 0.68 W/m^{2}K. It is a serious source of draughts – from between the floor boards, behind the skirtings and around all the penetration holes. There are two options available for upgrading a suspended timber floor: adding insulation and air tightness to an existing structure or replacing it with insulated concrete floor and both are discussed below.

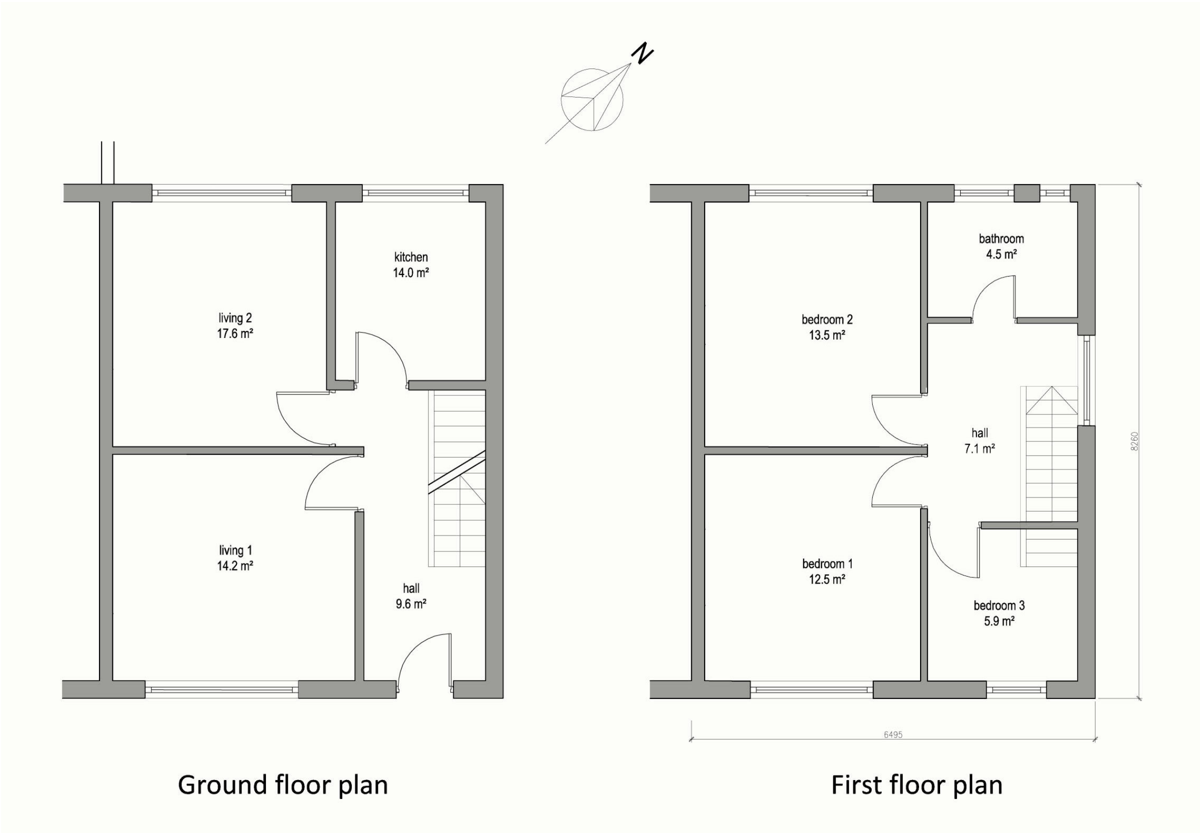

Figure 1. Case study house – plans

a. Upgrading existing timber floor

In the case study house the space available for insulation between the existing joists is limited to 110mm (insulation should not be installed below the joists to keep the original ventilation void). For this depth, the U-value of 0.18 W/m^{2}K could be achieved for rigid phenolic insulation with thermal conductivity of 0.022 W/mK. However, even though it provides the best U-value, its application between timber joists poses a risk of water condensation in timber structural elements, as explained below. For that reason it should be avoided in this application. The least expensive and easy to install material would be the mineral wool (thermal conductivity of 0.04 W/mK) that would achieve U=0.26 W/m^{2}K. However, it is fully permeable, so its installation does not address the air tightness in any way. The most effective material suitable for the floor application is open cell sprayed foam. Once it is installed after all the elements penetrating the floor are in place, the expanded foam fills all the gaps and both insulate and seal the floor. With thermal conductivity of 0.038 W/mK it provides a U-value of 0.24 W/m^{2}K. To add air tight layer to upgraded timber floor it is recommended to replace the old floorboards with chipboard and ensure sealing all the joints (EST, 2011).

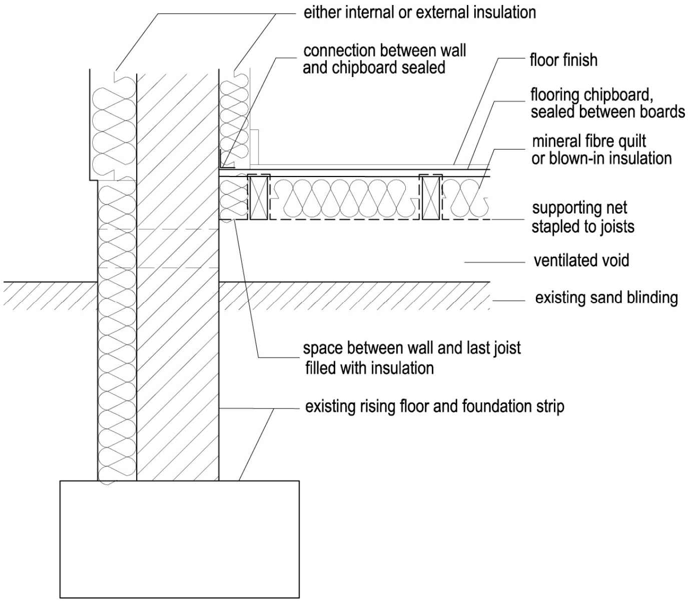

Figure 2. Existing suspended timber floor insulation. Adapted from: EST (2011)

b. Replacing existing floor with insulated concrete floor

The removal of existing timber floor and replacing it with new concrete structure gives an opportunity to install more insulation and a new damp proof membrane (DPM) to achieve very good air tightness. It is important to maintain the continuity of insulation between wall and floor. Insulation can be placed above the concrete floor in case of internal wall insulation and when a low thermal mass is preferred (Fig. 3). Insulation below the concrete is better suited if an under floor heating system is planned (the pipes can be installed in upper part of the slab) or when a high thermal mass is desired. In that case a layer of insulation should be installed between the concrete slab and rising wall to minimize thermal bridge (Fig. 4). A DPM playing a role of air tightness barrier should be installed under the insulation, lapped up the wall and sealed in case of both solutions.

In the case study house, the depth from the finished floor level to existing floor sand blinding is 300mm. The necessary floor finish and concrete slab should be 130mm, so the following U-values could be achieved assuming 170mm of insulation is added on top of the existing sand blinding:

- U =0.17 W/m^{2}K for white polystyrene insulation, $\lambda = 0.04$ W/mK;
- U =0.11 W/m^{2}K for phenolic insulation, $\lambda = 0.022$ W/mK.

In case of a removal of the existing sand blinding, any thermal transmittance can be achieved, for example 300mm of grey polystyrene insulation provides a U-value of 0.09 W/m^{2}K.

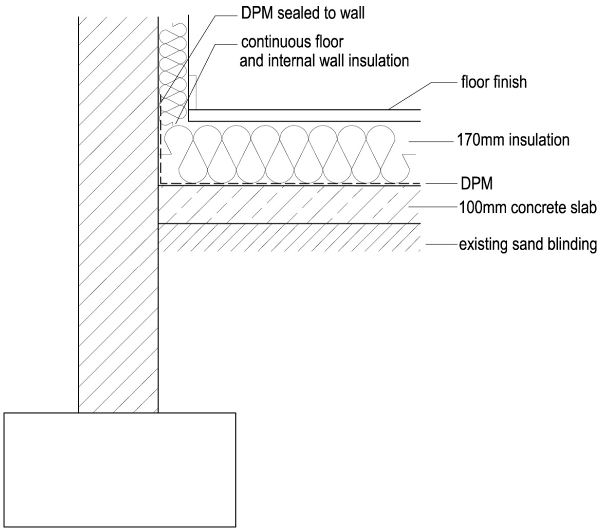

Figure 3. Existing suspended timber floor replaced by concrete floor with insulation above the slab. Adapted from: Energy Saving Trust (2011)

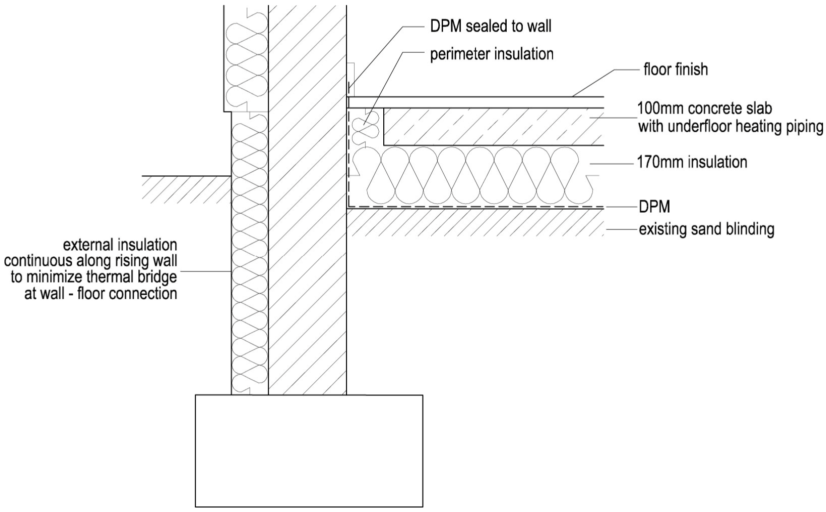

Figure 4. Existing suspended timber floor replaced by concrete floor with insulation below the slab. Adapted from: Energy Saving Trust (2011)

c. Phenolic insulation between timber joists

When a closed cell, non breathable insulation material like phenolic board is installed between timber joists, it will not allow the water vapour through, so if any moisture gets through the barrier (for example if incorrectly fitted) – it will get to the timber, which could cause its damage over time.

The smaller the thermal conductivity of the insulation material, the bigger of a thermal bridge the timber joists are becoming and the bigger is the risk of water condensation in structural wood. Thus, phenolic insulation should only be installed between structural timber if there is limited space not allowing for installation of other breathable insulation material and under a condition that the water vapour (and air tightness) barrier can be installed as a continuous layer and will not be damaged during the lifetime of the installation.

d. Calculations

Table 1 shows a comparison of four chosen options for the floor insulation. Option A includes installation of the 110mm open cell foam spray between the existing timber joists, as it provides the simplest and least expensive solution that allows improving the air tightness in timber floor. Its cost consists of the insulation and new chipboard installation. For the improved U-value all other options involve removing the existing timbers and installation of DPM, new concrete slab, insulation and screed. Options B and C assume the existing sand blinding is left in place, so that a 170mm layer of insulation can be installed, but different insulation materials are used: less expensive white polystyrene in option B and better performing, but more expensive phenolic rigid insulation in option C. Option D includes removing the existing sand blinding and installation of 300mm of the less expensive polystyrene.

The specific space heating demand of the house (column 2) was calculated with PHPP. The calculations for options A to D are derived from the baseline settings, with the U-value of the upgraded element changed according to column 1. The saved energy (column 3) is a difference between the baseline performance and upgraded heating energy. The capital cost (column 4) is estimated from the quotes for similar projects conducted by the author during 2011 and from supplier price lists published online. Columns 5 and 6 indicate the costs and energy savings per meter square of the house.

		(1)	(2)	(3)	(4)	(5)	(6)
		U-value [W/ m^2/K]	Heating Energy [kWh/m^2/y]	Saved energy [kWh/m^2/y]	Capital Cost [€]	Cost/TFA [€/m^2]	Saved kWh/ m^2/y per 1€
	Baseline - suspended timber, no insulation	0.68	394				
A	110mm sprayed foam between the joists	0.24	377	17	€1,876.00	€21.56	0.79
B	170mm white polystyrene + 100mm concrete floor	0.17	375	19	€3,414.32	€39.25	0.48
C	170mm phenolic + 100mm concrete floor	0.11	372	22	€4,304.08	€49.47	0.44
D	300mm grey polystyrene + 100mm concrete floor	0.09	371	23	€4,915.12	€56.50	0.41

Table 1. Floor refurbishment options

e. References

EST (2011) *Sustainable refurbishment* [Online]
Available at: http://www.energysavingtrust.org.uk/Publications2/Housing-professionals/Refurbishment/ Sustainable-Refurbishment-2010-edition (Accessed: 8 May 2011)
EST - Energy Saving Trust