

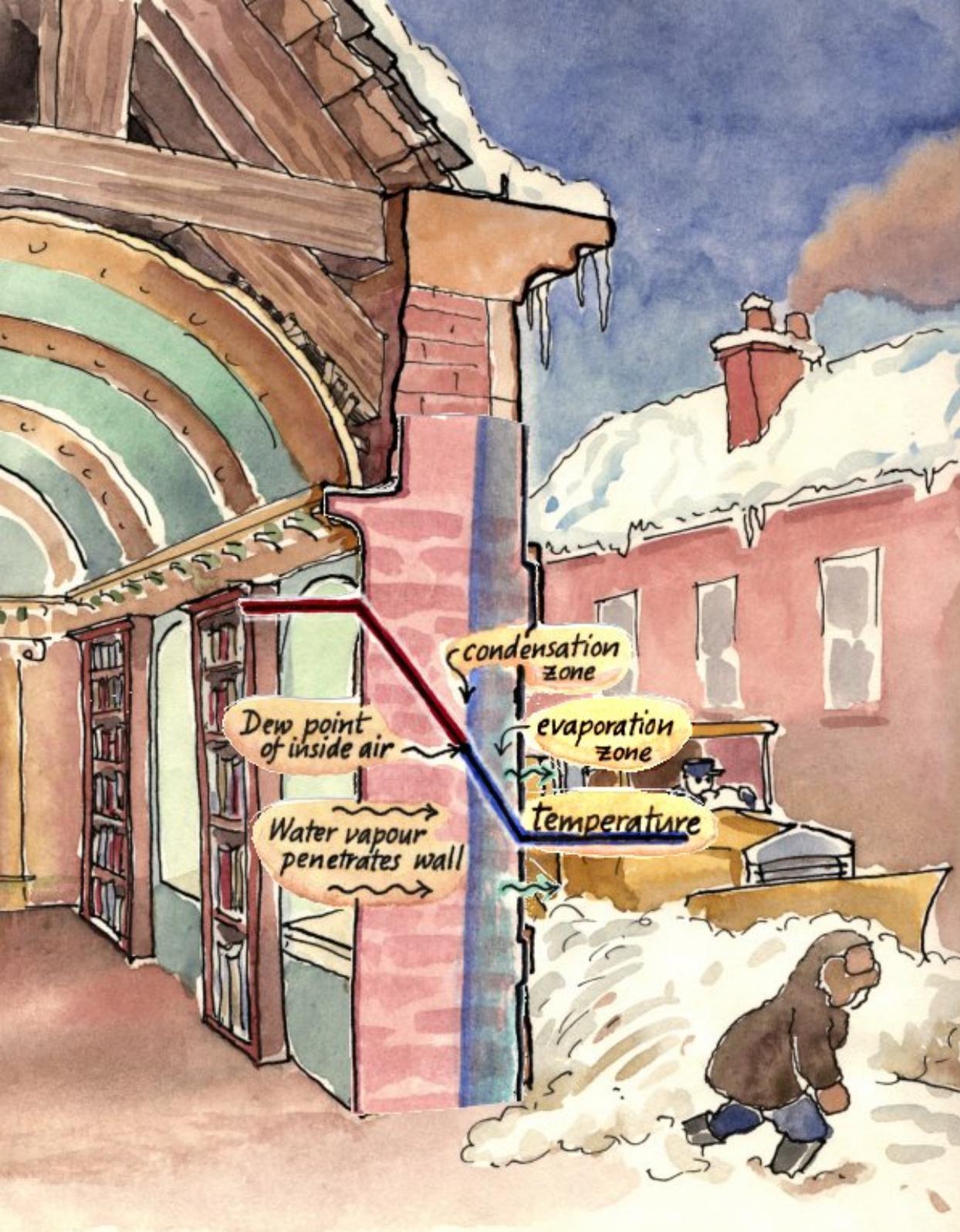
Breathability

A review of how buildings react to the excess water vapour inside



by Tim Padfield, www.conservationphysics.org

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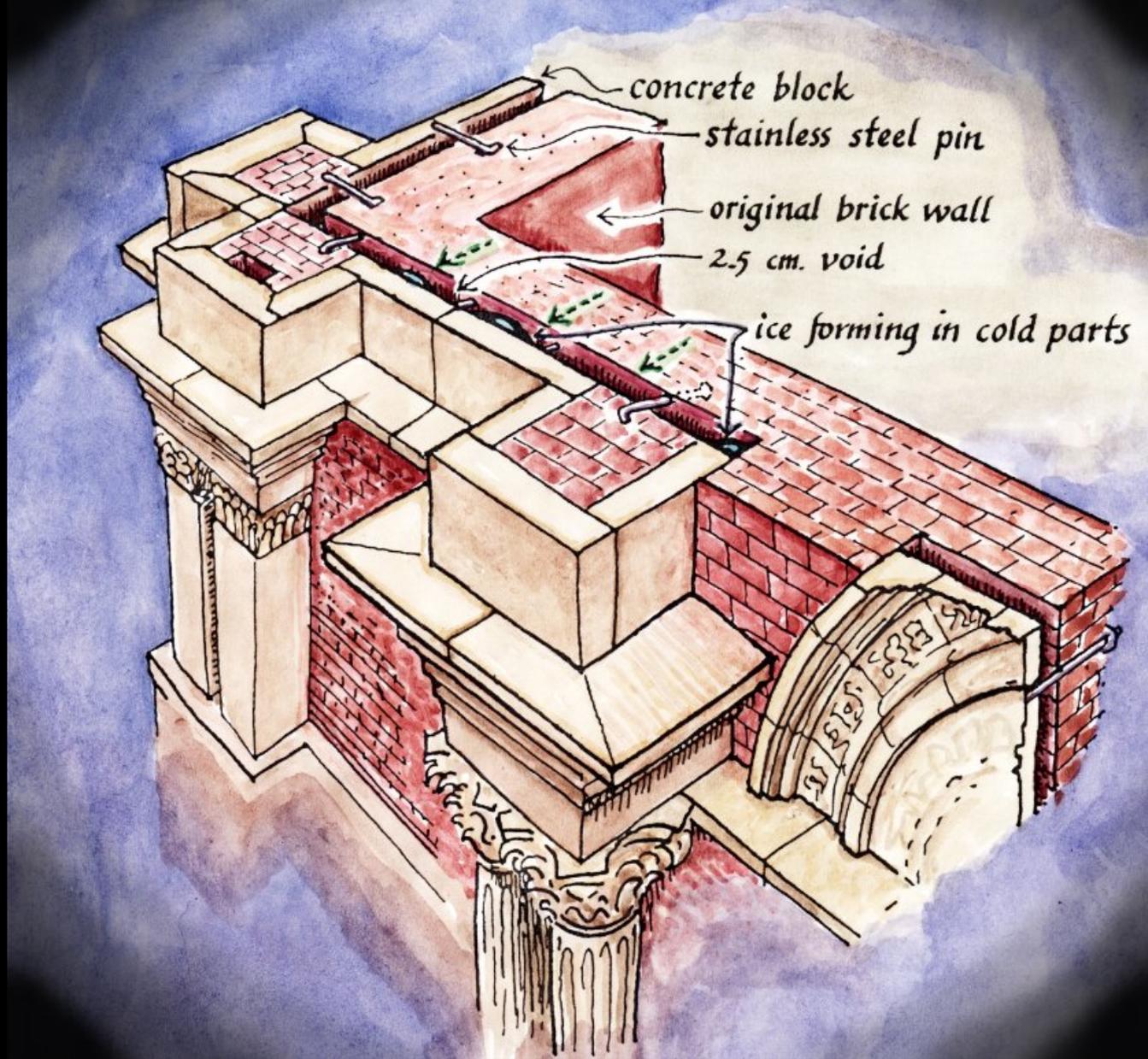


In a cool climate the temperature gradient across the wall passes through the dewpoint of the inside air

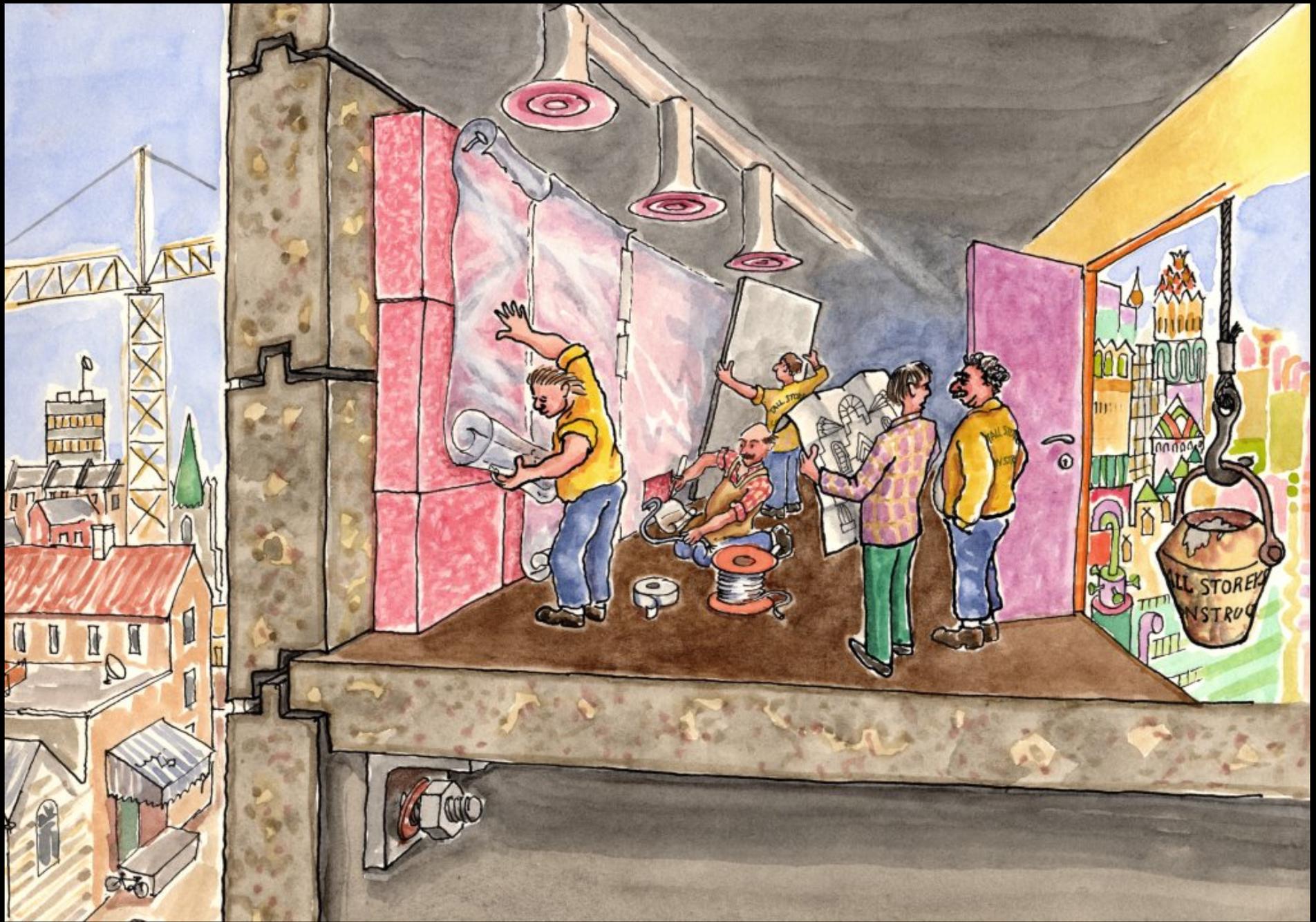


The Renwick Gallery, Washington DC

Few buildings are simple, homogeneous structures



Water vapour diffusing through the massive brick inner wall moves sideways within the air gap forming ice lenses where the gap is coldest

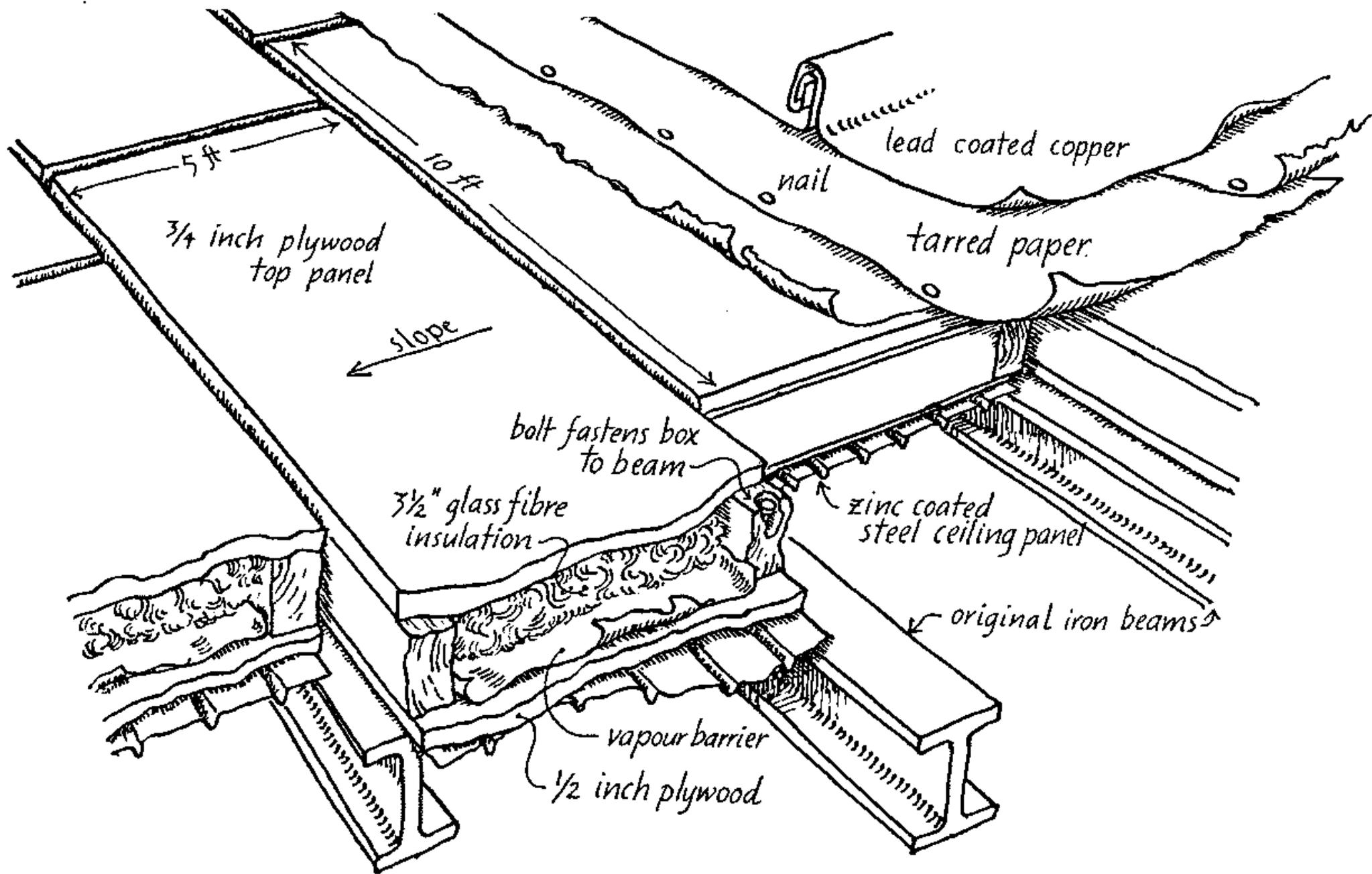


The engineer's solution to condensation in cold places is to put in an air barrier

In real buildings water vapour moves through cracks many times faster than it diffuses through materials, but computer programs cannot model the immense variety of human error



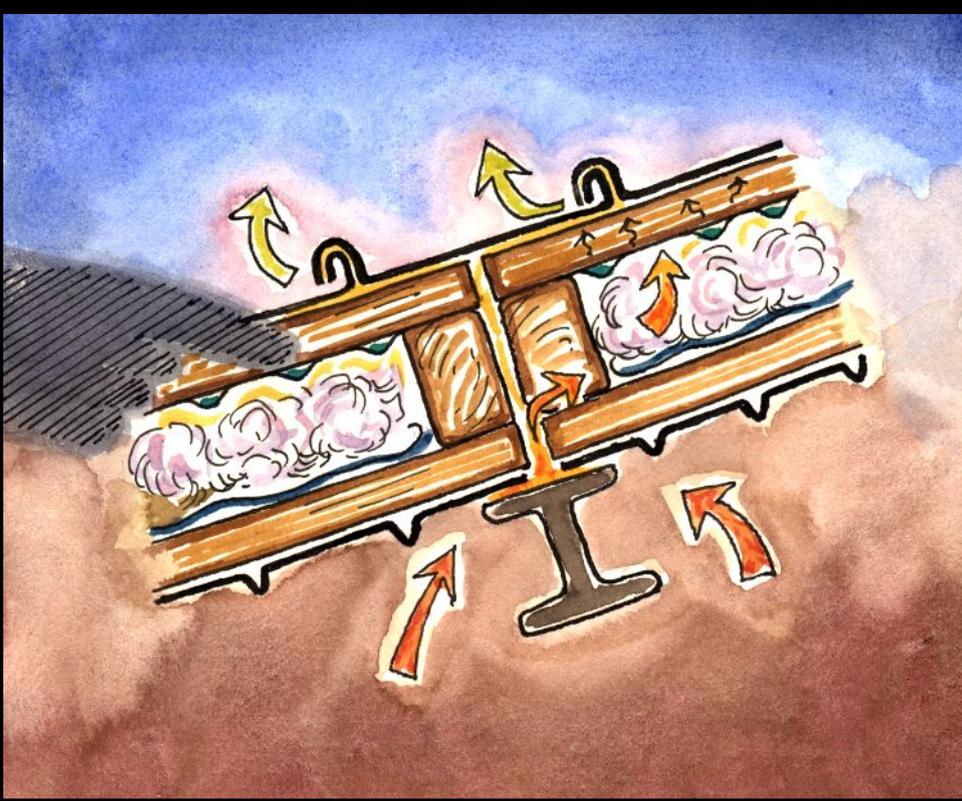
The Arts and Industries Museum, Washington DC



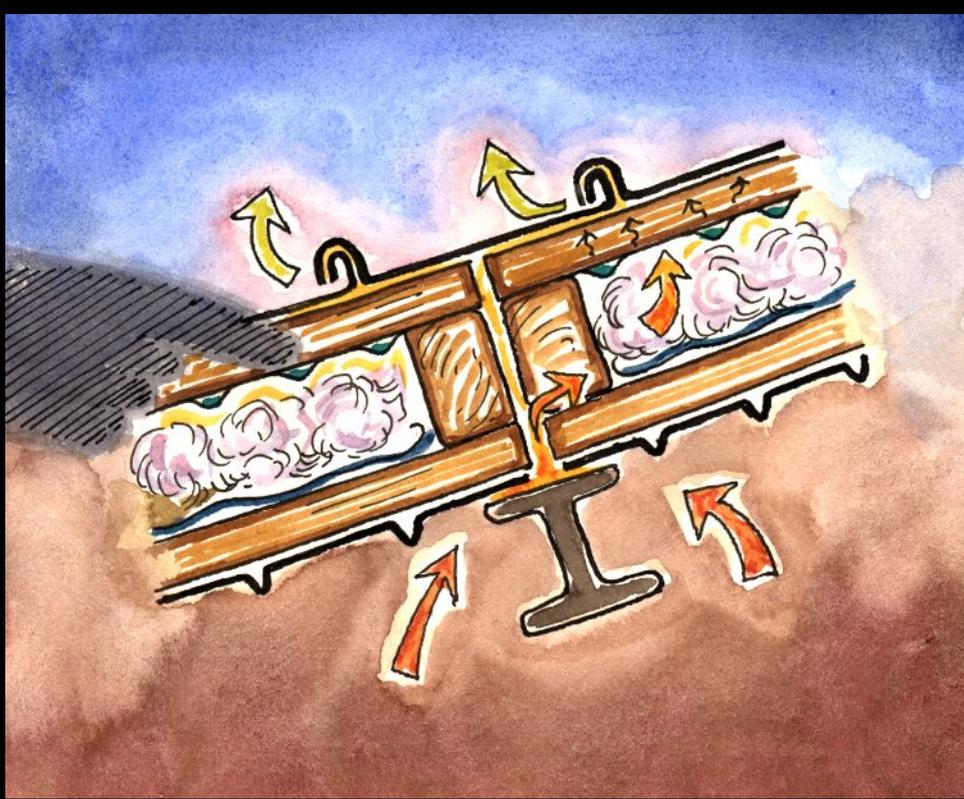
Most buildings have a combination of large scale structural porosity and fine scale material porosity



Water vapour moves through the structure mostly entrained in a flow of air. Diffusion plays a relatively minor part in the transfer of water vapour

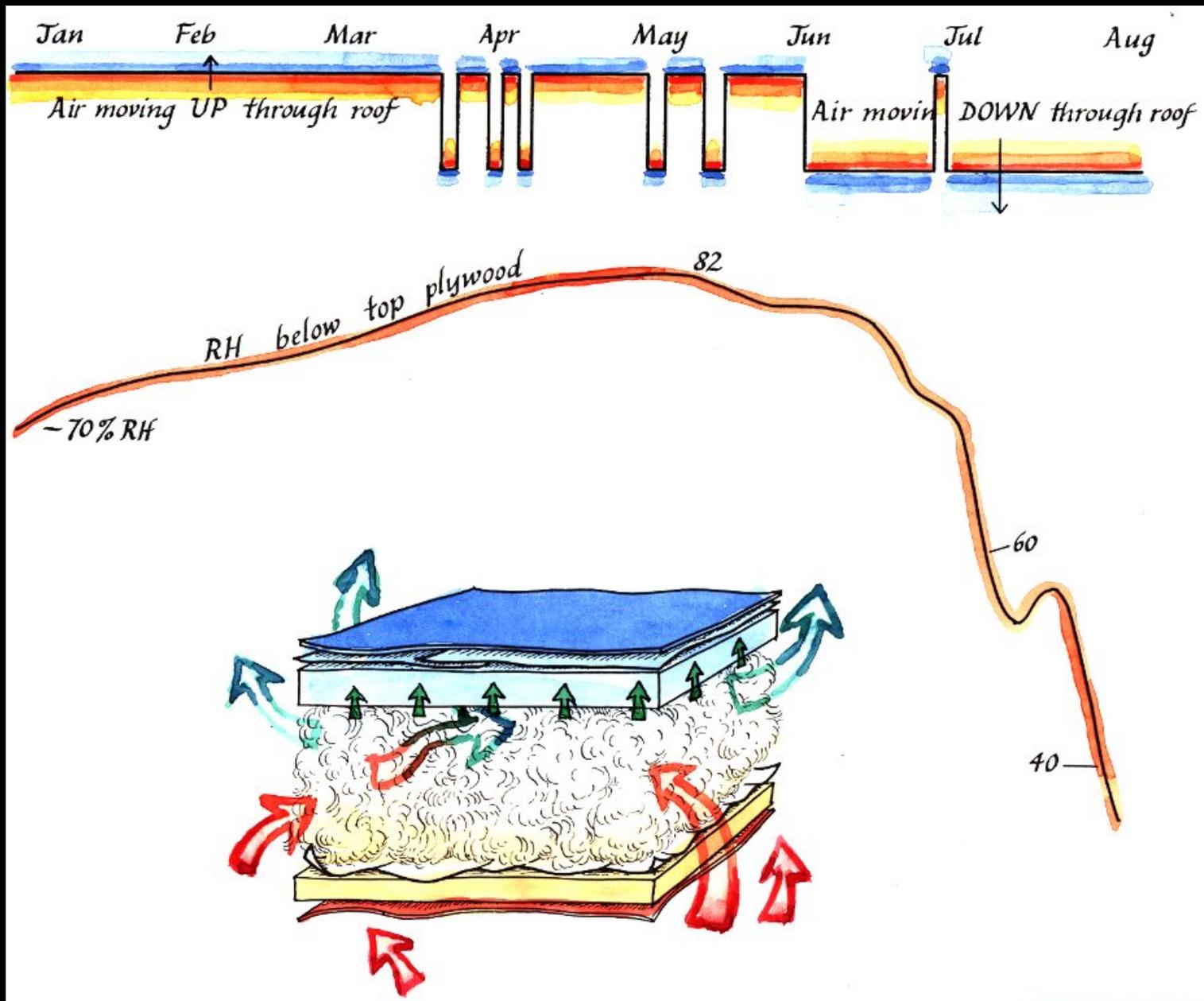


In winter, the cold upper plywood soaks up water condensing from air flowing through the gaps



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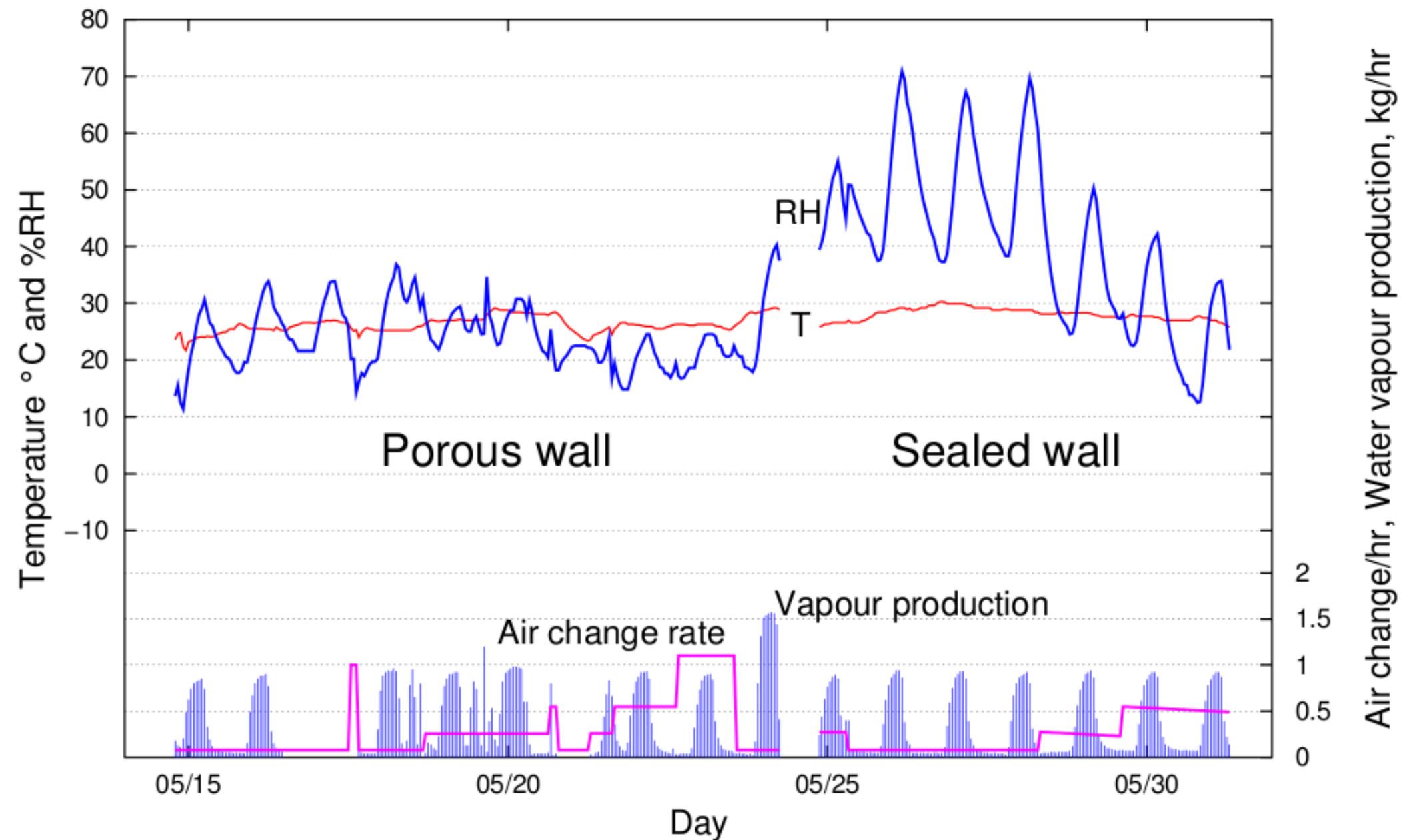
In summer the heated plywood distills water to condense on the plastic vapour barrier, where it accumulates, then cascades into the interior



The rain falling in clear spring sunlight was dramatic but short lived. This is an annual breathing cycle driven by the stack effect

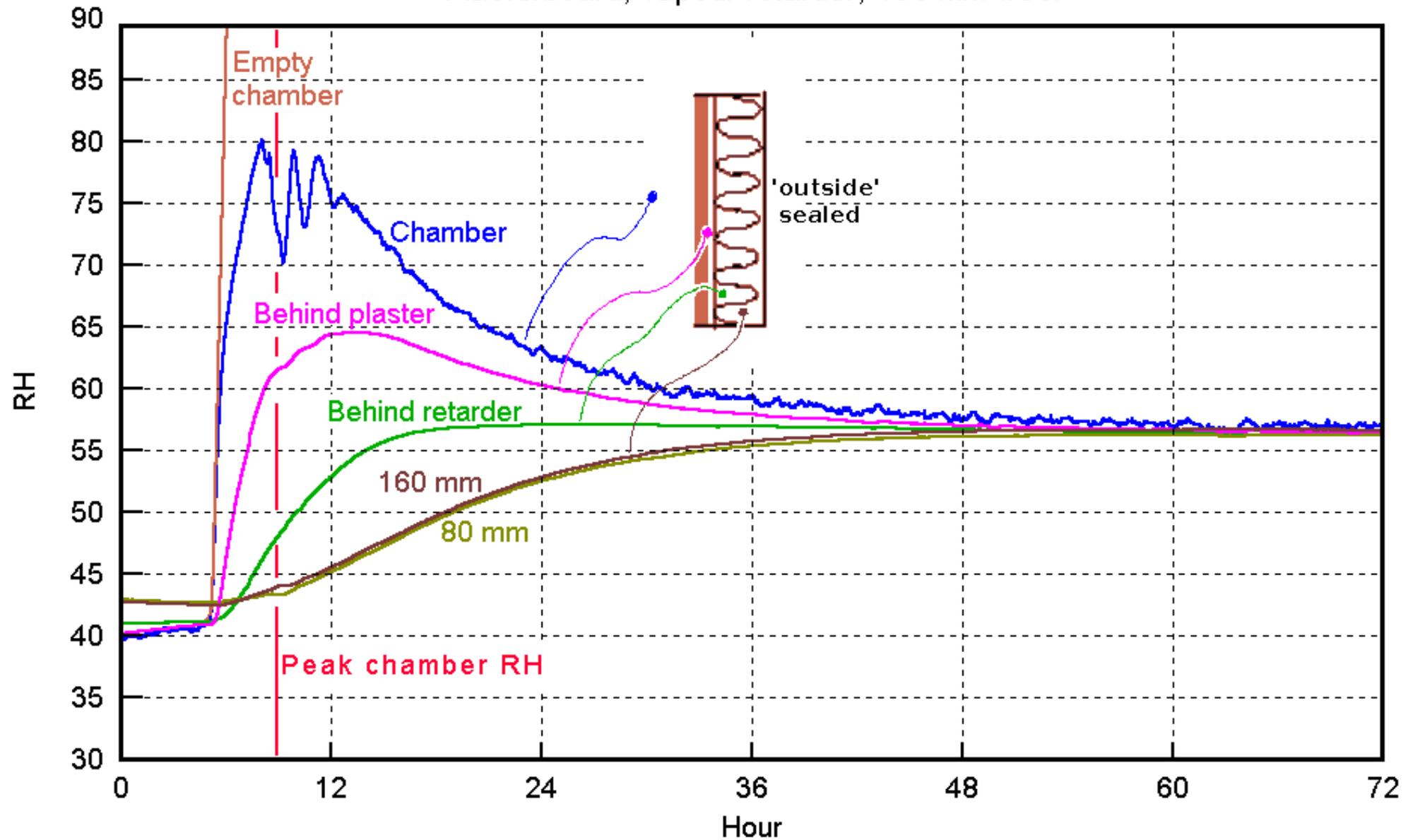


Vapour diffusion, rather than flow, plays a larger role in moderating the daily cycle of indoor climate



Sweet sleep, graphically displayed
(after Cary Simonson)

Plasterboard, vapour retarder, 160 mm wool



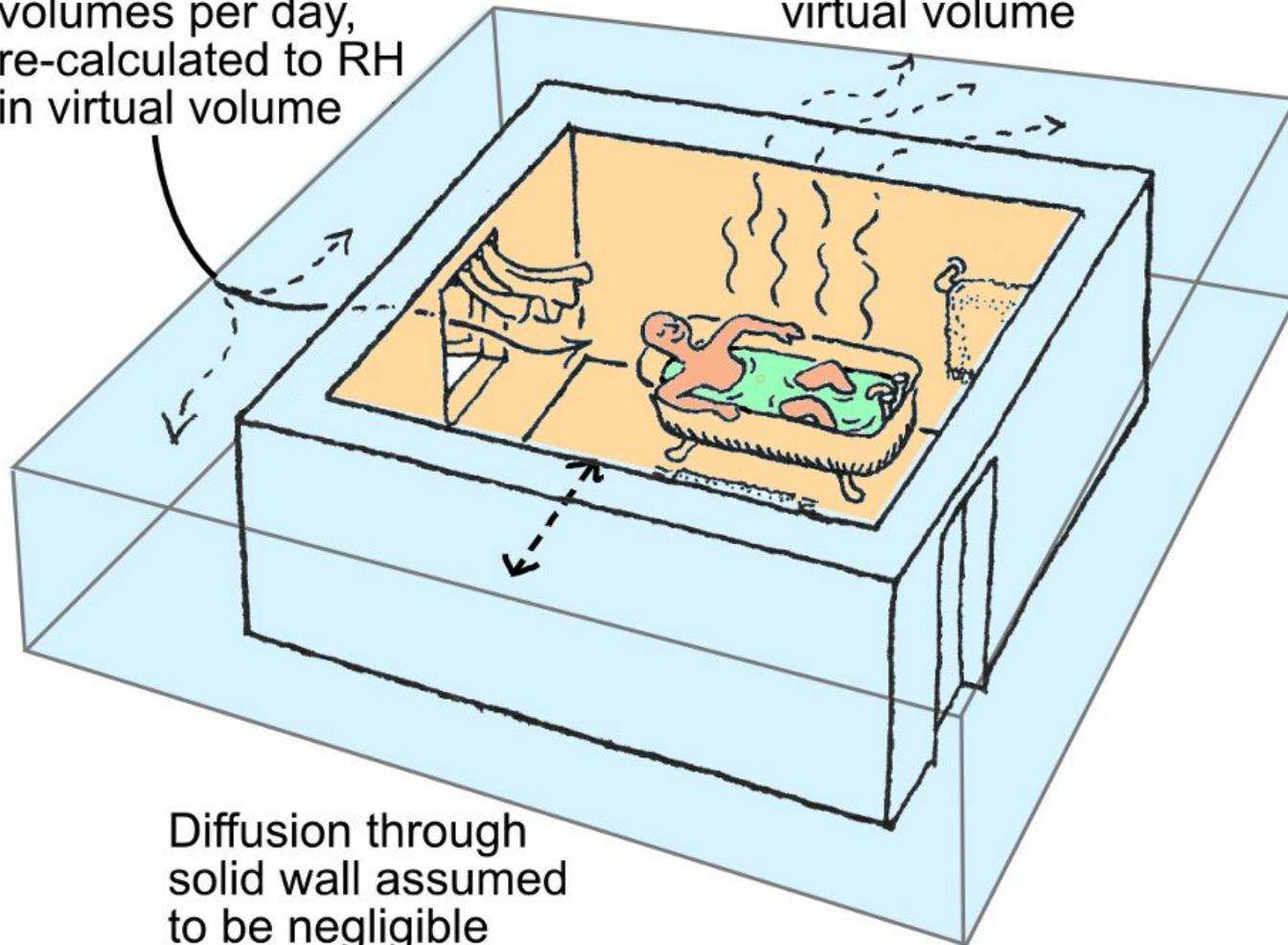
What happens if one forgets to turn off the heat under the pasta



The inside climate is defined by competition between **ventilation** and **buffering** by the wall surface, and by furniture. Diffusion through the wall plays no significant part

Water vapour in actual infiltration volumes per day, re-calculated to RH in virtual volume

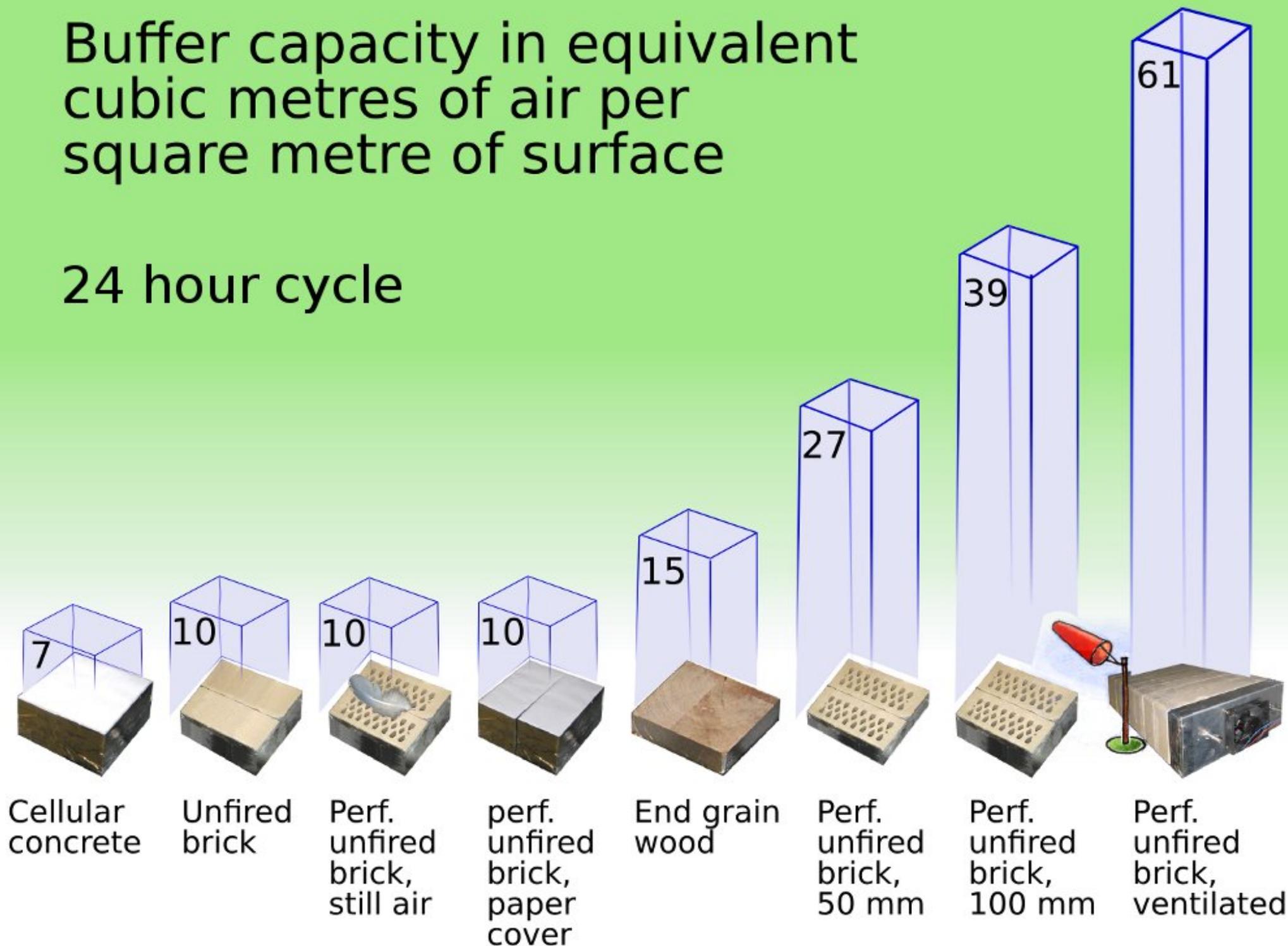
Internal vapour flux transformed into RH of virtual volume



Breathability, interpreted as the water buffer capacity of the interior wall surface, can be expressed as a larger, virtual volume of the room, into which the vapour fluxes disperse

Buffer capacity in equivalent cubic metres of air per square metre of surface

24 hour cycle





Lime plaster is famous for its permeability but in this wall painting the face of the figure in the middle has been preserved by varnish while the rest of the picture has disintegrated through salt recrystallisation



*Strøby church
Denmark*