Patrick Ryan Associates

Facades & Condensation Risk Analysis

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What is Condensation?

Condensation is the process of water vapour in the air condensing from gas into its liquid form. In buildings it occurs when warm moisture air meets with cold vapour-resistant surfaces.

One example of condensation is the formation of dew. When the air temperature cools to what is called the dew point, water vapour can collect in liquid form and settle on cold surfaces. Water vapour will only condense on a surface when the temperature o9f the surface is cooler than the water vapour’s temperature.

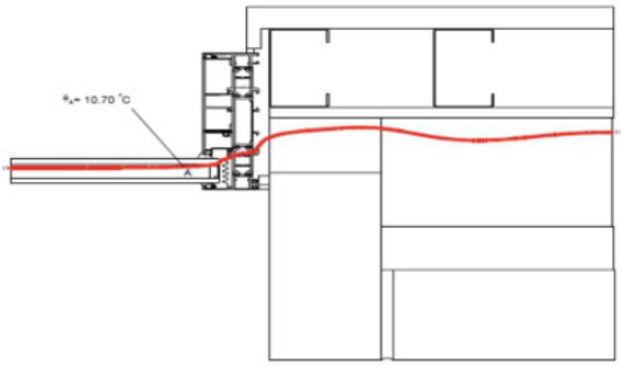

Figure 1 - Drew Point line shown within a typical façade construction

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It is worth going into more detail about the two different types of condensation that can affect buildings:

- Interstitial condensation: is condensation which occurs between layers of the construction, ('inside' the roof, wall or floor elements). Interstitial condensation can cause deterioration or even failure of the components of the assembly, potentially shortening their useful lifespan. It is important to ensure an element is designed to avoid interstitial condensation, or to create an adequate ventilation solution to remove any condensation that is formed.

- Surface condensation: is condensation which occurs on the visible surfaces of a construction, rather than between the layers. Surface condensation can promote mould growth, thus reducing indoor air quality, as well as creating unsightly pattern staining. Thermal bridges can undermine effective insulation and can contribute to the formation of surface condensation as the heat is drawn out, leaving the inner surface cold.

Both types are very important and must be studied separately to minimise the risk. Nowadays, we have different tools to do so.

On one of our projects, we were instructed to carry out a condensation risk analysis on a timber construction where we needed to understand if the issues of deterioration were caused by the effects of interstitial condensation.

Figure 2 –Signs of deterioration within the built-up

What is currently happening to that element?

We all know the prolonged effects of condensation - mould growth, deterioration of the materials etc., but what is currently happening to such solution on a day-to-day basis?

One of main issues is that if the insulation material is saturated (every air space filled with water), as in this case, then its conductivity is getting worse, meaning the heat transfer through the construction is higher. This can be better explained through the following diagram:

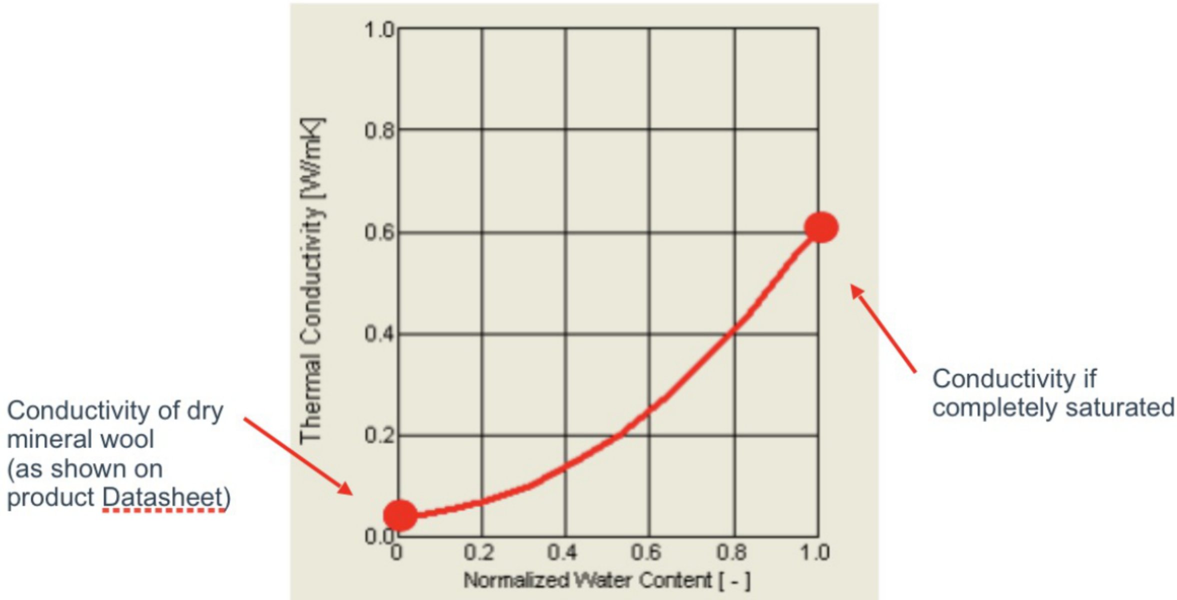

Figure 3 - Conductivity variation of mineral wool

U-value of the roof:

- Dry mineral wool: U=0.11 W/(m2*K);
- Completely saturated mineral wool: U=0.30 W/(m2*K) ← Worst case scenario

As can be seen, the thermal performance (U-value) for that element is considerably worse in case the insulation is completely saturated.

It does not comply with building regulations; heat transfer through the element would be higher which would increase the monthly bills for the residents and also an increase on CO_2 emissions.

Conducting an accurate hygrothermal assessment of the building elements will provide critical information for both surface and interstitial condensation risk assessment.

Tools for the hygrothermal assessment

Hygrothermal assessments can be performed using various tools. In the UK, the software used need to be recognised by a British industry body such as BRE. Some of the suggested recognised software includes:

Surface condensation risk analysis

- Bisco or Flixo (2-D finite element analysis)
- Trisco (3-D finite element analysis)

Both software packages mentioned on page 3, analyse the dew point line, so the optimal position of any vapour control layers can be evaluated.

They are fundamental in the calculation of cold bridging (more information is available on this in our article Cold Bridging in Rainscreen Cladding)

Interstitial Condensation risk analysis

- BuildDeskU (limited to 1-D analysis – Glaser method)
- WU-FI Pro (dynamic simulation on vapour diffusion but again limited to 1-D analysis on simple solutions and not junctions)

These tools are helpful, but they are limited. With exception to the WUFI, they use the Glaser method to identify vapour diffusion, and use steady temperatures to evaluate the risk.

This method assumes vapour moves only one way (inside to outside), completely omitting the possibility of driving rain from its calculations, but does not measure absorption or porosity, and therefore misses the potential risk attributed to the aspect of moisture storage.

This renders the results inaccurate, as the Glaser method it is only used on 1-D analysis (ex. a simple wall solution). Therefore, we cannot evaluate the vapour diffusion of junctions using this approach.

The only software currently available for junctions, is Wu-FI 2D (different from Wu-Fi Pro). But even this falls outside the scope of the standard even though it has been repeatedly validated.

The future of Hygrothermal assessments in the UK

The Part L of the building regulations have been updated with the latest revision in 2023.

Potentially we can sell it as an old article with mentioning the fact it is good to see the tightening of the thermal performance with the new amendment and the net zero requirements.

Building Regulations and environmental policies are rapidly changing and there are deadlines where we must reach certain goals with regard to CO2 emissions.

If we want to reach these goals then the Building Regulation Approved document Part L (incorporating the latest 2023 amendments) still requires another leap forward and have a vision for the future closer to LETI's (London Energy Transformation Initiative), where 100% of all built new buildings are net zero by 2030.

This means that more restrictive conditions, on thermal performances will have to be met and the condensation issues will rise even further. It seems like our industry is starting to evolve on the matters of the climate emergency but still not fast enough to meet the targets.

More emphasis needs to be put into cold bridging, condensation risk analysis and an accurate study should become mandatory.

Even our software needs to evolve. Condensation analysis is one of the most complicated matters that affects our building and currently there are no standards that will tell us how to avoid that risk.

Looking further into the future, appears that accurate implementation of indoor boundary conditions will be required to accurately assess condensation risk of wall assemblies with typical heating systems.

Future work will include 3-D Computational Fluid Dynamics (CFD) modelling simulation to evaluate the effects of 3D supply forced-air flows at the room-window corners. Other relevant factors to be considered include the presence of furniture and blinds in reducing convection and radiation heat transfer. But before getting into such complicated analysis (I will estimate about 20 years before we start looking into these things) let's focus into more cheaper solutions based on the software currently available.

For more information about the services provided by **Patrick Ryan Associates**, please contact us.

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