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Condensation effects on structural durability

Interstitial condensation can cause structural damage due to timber rot or corrosion of reinforcement. New risk assessment techniques which allow for ventilated cavities and determine the effect on hygroscopic materials are being developed by BRE. *Chris Sanders* reports.

A proportion of the water vapour produced within a building escapes by diffusion through the walls or roof. Condensation may then occur within the structure, increasing the risk of timber decay, metal reinforcement corrosion or degradation of thermal performance. Even in the absence of condensation, high humidities will cause timber and other hygroscopic materials to have high moisture contents.

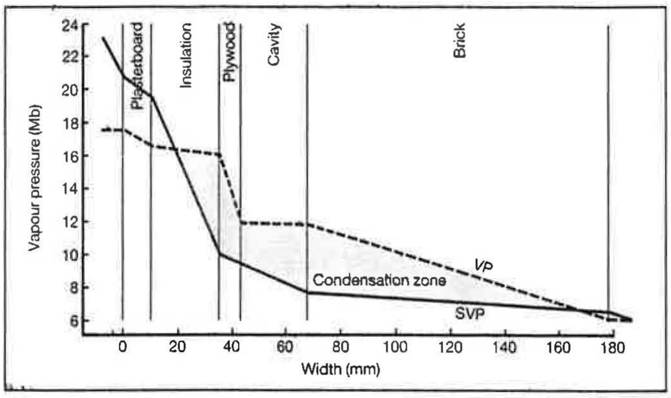

Figure 1

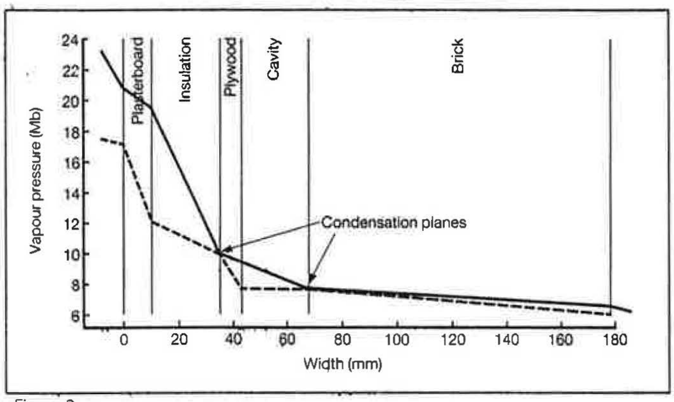

Figure 2

In the following building types the risk from interstitial condensation is high:

□ high internal moisture loads (eg swimming pools);

□ susceptible structural components or reinforcements which can corrode;

□ impermeable outer membranes (eg metal cladding).

Traditional assessments of condensation risk have been made in CIBSE Guides and British Standards by taking given internal and external environmental conditions and calculating the profiles of both temperature, vapour pressure, vp, and saturated vapour pressure, svp, through the structure independently. Condensation was predicted in the zone where vp exceeded svp (Figure 1). This phenomenon cannot, of course, occur in practice.

The improved calculation procedure, incorporated in the CIBSE *Guide* (A10) and based on practical measurements, predicts that where condensation occurs a film of water forms so that the vp equals the svp. The vp profile is then recalculated using this constraint (Figure 2) Although condensation is predicted only at interfaces, materials on either side may be wetted by contact.

These types of calculation are simple, if tedious, to carry out manually. Given the availability of a microcomputer it is possible to undertake more sophisticated analyses. Particularly useful is the identification of critical internal conditions for the onset of condensation within a structure. This will allow constraints to be set on plant sizing etc.

Like all calculation procedures, the results are only as reliable as the input data. There are considerable variations in the values of vapour resistivities quoted in the literature for many common materials. These are being refined, but at present it is advisable to use "worst case" values and interpret the results accordingly.

Ventilating a cavity is often suggested as a means of reducing the incidence of interstitial condensation. However, explicit calculation of the effect of ventilation is complex. Little information is available on the ventilation rates in cavities.

In practice, a useful approach is to analyse the structure with the cavity unventilated, and then with the cavity conditions equal to outside. The realistic conditions will lie between these two extremes.

While any interstitial condensation is undesirable, the deposition of condensate may have harmful effects depending upon the materials in the construction. While brickwork can withstand a reasonable amount of wetting, similar quantities can cause damage in more susceptible materials.

Consequently, when condensation is predicted the amounts of water involved should be considered relative to the materials in the construction. It may not be worth carrying out major remedial measures to prevent a limited amount of condensation in a robust material.

Most porous materials can absorb moisture even though condensation does not occur. For most masonry materials, which can withstand slight wetting, the total amounts of water absorbed will be small unless humidities are maintained close to 100% for long periods.

Much more important is the absorption of water by timber, as exposure to sustained high humidities within the material can lead to moisture contents high enough to promote rot. Care should therefore be taken, especially when timber forms a structural element, to ensure that the vapour pressure throughout the material does not approach saturation.

Severe interstitial condensation with major accumulations of ice can occur in the structure of cold stores. Similar problems arise in the insulation around pipes carrying refrigerated liquids or gases. When assessing condensation effects, the calculation should proceed from warm (in this case outside) to cold (inside) as usual.

Measures to prevent condensation will depend crucially on the presence and effectiveness of the vapour control layer on the warm side of the structure.

As with surface condensation, the first essential to minimise the risk of interstitial condensation is to control the environmental conditions within the building as effectively as possible. However, in many buildings, humidities will inevitably be high. Also, in many constructions which are senstitive to damage, the cost of controlling environmental conditions amy be excessively high.

In these situations it will be necessary to ensure at the design stage that the risk of interstitial condensation is acceptable either by inclusion of vapour control layers or, where relevant, ventilation of cavities.

BRE has developed a computer package incorporating these ideas, which more accurately predicts interstitial condensation and assesses possible remedial strategies for building structures. This will be available shortly and will be linked to the new British Standard on condensation control, *BS 5250*.

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