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THE ELIMINATION OF CONDENSATION RISK IN LOW ENERGY BUILDINGS—A CASE STUDY

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SYNOPSIS

In a recent report on interstitial condensation risk in low energy housing, prepared by London consulting engineers Buckle & Partners for the Architect's Section, Department of Technical Services, London Borough of Richmond-upon-Thames, the consultants checked for condensation in the proposed external wall construction, and analysed alternative vapour barrier positions and construction variations. As a result of their study the consultants were able to make a number of positive recommendations.

Using newly developed computer-aided techniques the consulting engineers demonstrated that:

(1): Interstitial condensation would occur in the proposed basic construction if no vapour barrier were included.

(2): The placing of a vapour barrier would prevent interstitial condensation occurring up to 53% RH internally, but the correct placing of such a vapour barrier would be hampered by wall ties and fixing difficulties.

(3): A plasterboard dry lining construction with aluminium foil backing would avert the fixing problem and raise the level of RH before interstitial condensation could occur.

The technical content of this article is based on the consulting engineers' report.

Introduction

Moisture producing activities take place in most buildings. Some manufacturing processes release a large amount of water vapour into the internal air. Bathrooms, kitchens, laundries, and swimming pools are also sources of high humidity and the combustive products of gas, oil, and paraffin are rich in water vapour.

The amount of water vapour present in the atmosphere varies according to the weather conditions. Water vapour is generated indoors according to type of use.

In UK winter conditions, the water vapour pressure is generally higher indoors than outdoors for occupied buildings, causing some of the water vapour to diffuse through the walls; the thermal and vapour resistance of the walls may be such that part of this water vapour is deposited either as surface condensation on the walls or within their thickness as interstitial condensation.

In order for designers to take account of these activities to enable them to produce designs which are satisfactory it is important that condensation risk is eliminated.

General

The consulting engineers' Report gave results and recommendations following a computer aided study of the likelihood of interstitial condensation occurring within the external wall structure of proposed low energy housing. Where necessary the consultants suggested modifications to the structure in order to negate problems occurring under the planned conditions.

By interpretation of the computer read-outs the consultants were able to produce graphs showing the vapour and saturated vapour levels throughout different wall structures and where there was a risk of interstitial condensation.

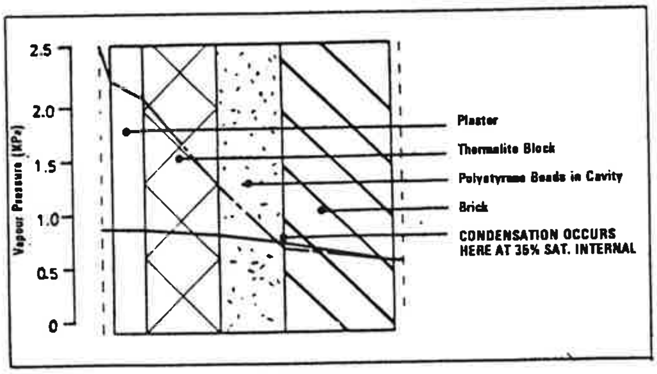
Alternative methods of construction requiring a vapour barrier assumed it could be embodied in the construction free from any perforations through which moisture might migrate.

Method

The consulting engineers were presented with preliminary plans of the proposed low energy housing, along with suggested construction for traditional walls with cavity insulation, as shown in Figure 1.

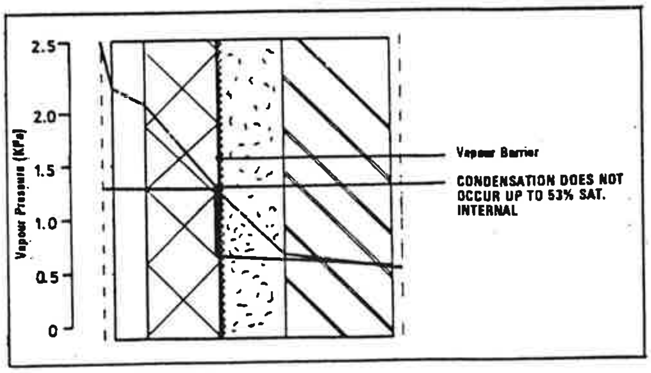
This construction formed the input for the computer program, using constants relating to the various materials used. These constants included the thickness, thermal conductivity, density, and specific heat of each material. In the case of the expanded polystyrene bead loosefill insulation in the cavity, it was assumed that the polystyrene would occupy 80% by volume of the space, the remaining 20% being occupied by air between the beads.

Throughout the study standard design temperatures of 21°C internal and −1°C external, with 100% external relative humidity were used for purposes of comparison of options.



— - —: saturated vapour pressure
———: structure vapour pressure

Figure 1: Vapour pressure across traditional wall with cavity insulation. Interior 21°C; exterior −1°C, 100% saturation.



— - —: saturated vapour pressure
———: structure vapour pressure

Figure 2: Benefit of adding vapour barrier to traditional wall with cavity insulation. Interior 21°C; exterior −1°C, 100% saturation.

Appendices

Appendix 1: Construction as in Figure 1 — Computer Read-out.

Materials ϕ Interfaces	Resistance (m^2 °C W^{-1})	Interface Temperature (°C)	Interface V.P. (kPa)	Saturated V.P. (kPa)
INSIDE		21.0	0.87	2.49
Surface layer	0.122			
		19.4	0.87	2.25
Plaster L/W	0.081			
		18.3	0.86	2.10
Thermalite	0.575			
		10.7	0.81	1.28
Poly beads	0.683			
———		1.6	0.73	0.69
Brick outer	0.125			
		-0.1	0.56	0.56
Surface layer	0.071			
OUTSIDE		-1.0	0.56	0.56

———: means that condensation may occur.
U-value of complete construction = 0.60 W m^{-2} °C^{-1}.

Appendix 2: Construction as in Figure 2 — Computer Read-out.

Materials ϕ Interfaces	Resistance (m^2 °C W^{-1})	Interface Temperature (°C)	Interface V.P. (kPa)	Saturated V.P. (kPa)
INSIDE		21.0	1.32	2.49
Surface layer	0.122			
		19.4	1.32	2.25
Plaster L/W	0.081			
		18.3	1.31	2.10
Thermalite	0.575			
———		10.6	1.29	1.28
Polythene Sheet	0.003			
		10.5	0.66	1.27
Poly beads	0.683			
		1.4	0.63	0.68
Brick outer	0.125			
		-0.3	0.56	0.56
Surface layer	0.055			
OUTSIDE		-1.0	0.56	0.56

———: means that condensation may occur.
U-value of complete construction = 0.61 W m^{-2} °C^{-1}.

Appendix 3: Construction as in Figure 3 — Computer Read-out.

Materials ϕ Interfaces	Resistance (m^2 °C W^{-1})	Interface Temperature (°C)	Interface V.P. (kPa)	Saturated V.P. (kPa)
INSIDE		21.0	2.14	2.49
Surface layer	0.122			
		19.4	2.14	2.26
Plaster board	0.081			
———		18.4	2.14	2.11
Al foil	0.006			
		18.3	0.69	2.10
Airspace UV=5mm	0.062			
		17.5	0.69	2.00
Thermalite	0.575			
		10.1	0.67	1.24
Poly beads	0.683			
		1.3	0.63	0.67
Brick outer	0.125			
		-0.3	0.56	0.56
Surface layer	0.055			
OUTSIDE		-1.0	0.56	0.56

———: means that condensation may occur.
U-value of complete construction = 0.58 W m^{-2} °C^{-1}.

Appendix 4: Construction as in Figure 4 — Computer Read-out.

Materials ϕ Interfaces	Resistance (m^2 °C W^{-1})	Interface Temperature (°C)	Interface V.P. (kPa)	Saturated V.P. (kPa)
INSIDE		21.0	2.49	2.49
Surface layer	0.122			
———		19.4	2.49	2.25
Glass sheet	0.001			
		19.4	0.73	2.25
Tile	0.004			
		19.3	0.72	2.24
Plaster L/W	0.081			
		18.2	0.72	2.09
Thermalite	0.575			
		10.5	0.69	1.27
Poly beads	0.683			
		1.4	0.65	0.68
Brick outer	0.125			
		-0.3	0.56	0.68
Surface layer	0.055			
OUTSIDE		-1.0	0.56	0.56

———: means that condensation may occur.
U-value of complete construction = 0.61 W m^{-2} °C^{-1}.

Modulating Control Dampers for Air Conditioning Systems (A Method of Sizing Dampers for Ducted Air Systems)

Continued from page 24

K_θ = pressure loss coefficient at blade angle θ.
N = damper authority.
R = damper resistance ($= K_\theta/2A_d^2$).
V = air volume flow rate (m^3 s^{-1}).
γ = inherent damper characteristic.
γ' = installed damper characteristic.
ΔP_d = pressure drop across fully open damper (Pa).
ΔP_s = pressure drop across system (Pa).
ρ = air density (kg m^{-3}).
θ = blade angle relative to axis of duct (°).
θ' = damper initial start angle (°).
ϕ = damper blade angle, $\theta' = 0$(°).

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