Incomplete resistance; ventilation, mould growth and built in furniturein a 1930’s Dublin clinker concrete apartment building

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Summary

Steady state and dynamic simulations tools based on current ISO standards play a crucial role in designing thermal envelopes that are robust and minimise risks of interstitial and surface condensation. These tools can also be used in a forensic way when supplemented byenvironmental and material data from site to analyse building failure. In this case study issues of mould and surface condensation observed in social housing apartments in a 1930’s building was investigated using ISO standards to show the impact of IWI, changes toventilation and role of cabinetry in exasperating critical levels of surface temperature in a 1990’s service and fabric upgrade.

Keywords: Ventilation, Solidwall building; Internal Wall Insulation; Condensation, Surface Resistivity, Temperature factor

Nomenclature

ISO	International Organisation for Standardisation		
IWI	Internal Wall Insulation	fRsi	Temperature Factor
CRA	Condensation Risk Analysis	Rsi/Rse	Interior/Exterior Surface resistivity
WUFI	Wärme Und Feuchte Instationär	Δ P	Vapour pressure difference, inside to outside (Pa)

1.

Figure 1. (a) photo of external access and external stair tower; (b) Thermal model through deck access, pre-refurb, showing ceiling temperature of 13.67C

83% of respondents in a recent (2021) resident survey from Dublin’s Oliver Bond social housing scheme reported having issues with damp and mould and 57.8% reported having been told that conditions were their fault and responsibility. These 396 apartments spread over 16 blocks in the city centre were constructed in 1938 of in situ cast ‘Clinker’ concrete, with external staircase and gantry access to each level. In the 1990’s the apartments were partially dry lined with 38mm mineral wool and service alterations which reduced room ventilation. Two case study apartments were selected each a 2 bed, east orientated, mid floor unit with 2 working adult occupants.

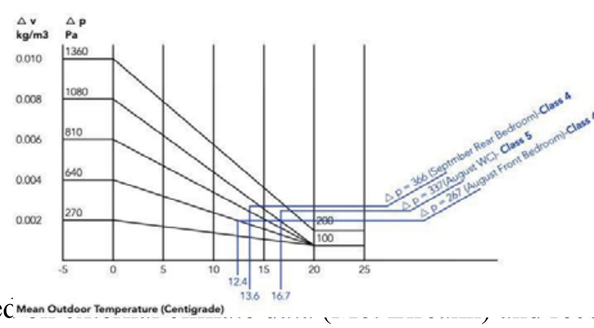
This study aimed to investigate the impact changes to ventilation and the discontinuously applied IWI. The study found that bespoke calculations for surface resistance (Rsi) were limited due to the linearisation of convective and radiative co-efficient values but found elevated values for Rsi in Austrian and German building codes [1] which better reflected the impact of furniture and built-in units on surface temperature than those offered by EN 6946[2] or EN 13788[3].

2. Methodology

Site investigation, material and environmental data was applied to three standards, EN 13788, EN 10211[4] (using Psitherm) and EN 15026[5] (using WUFI). Internal Temperature and humidity data was used to calculate the fRsi.min and max values and also the Humidity Class of the internal spaces[6]. These Classifications were subsequently modelled in WUFI where the impact of differing levels of surface resistivity was also simulated. Thermal modelling software was used to compare the impact on fRsi of the of the original and refurbished construction, surface resistivity as well as the impact of modelling with measured versus calculated values.

3. Results

Figure 2. (a)Impact of reduced ventilation; Humidity classification based on Delta P values in Apartment 205;



The fRsi.max results basec ... rded temperature and humidity for July-December showed different results for each apartment but the humidity class results for both apartments having class 4 (e.g canteen/sports hall) & 5 spaces(e.g. brewery/laundry) illustrating the impact of changes to the ventilation. These classes were incorporated into WUFI simulations but did not lead to critical levels of surface humidity. The thermal models revealed that in many locations the addition of IWI lowered the critical surface temperature as well as highlighting the impact of missing insulation and not returning IWI into reveals etc. Both WUFI and Psitherm modelling indicated the significant impact Rsi has on surface temperature. A mould risk was clearly identified in WUFI when combining both the humidity class and elevated surface resistance and risk was confirmed in WUFI Bio for the internal surface of the IWI. Further site inspection confirmed the lowest internal surface temperatures found at the back of wardrobes and around cabinetry and greater corelation between the measured/observed temperatures and thermal models was found where the 0.5 & 1.0 m^2K/W values were used.

Table 1. Thermal model results showing impact of interior surface resistance on surface temperature, fRsi and u-value.

Rsi Interior surfac	Rse Exterior surfac	Rsi Data Source	Surface Temperature at junction	fRsi	U-value for wall

e resista nce m^2K/ W	e resista nce m^2K/ W		of ext. wall & ceiling		W/m^2 K
0.13	0.04	EN 6946	15.31	0.77	0.682
0.25	0.04	EN 13788	13.64	0.68	0.630
0.50	0.04	DIN 4108-8	11.92	0.60	0.544
1.00	0.04	DIN 4108-8	9.98	0.50	0.428

4. Conclusions

The installation of IWI lead to a lowering of critical surface temperatures and increased the risk of condensation and mould. Changes made by landlord (to services/fireplace/boilers) and by tenant (installing cabinets) have increased the internal moisture loads to critical levels. Rsi values offered by EN 13788 and EN 6946 did not properly account for the impact on built-in cabinetry on surface temperatures (and fRsi) as recorded and observed on site. Surface resistivity has greatest impact where thermal transmittance is high, in poorly insulated buildings so the impact of cabinetry should be considered more by designers in the areas of refurbishment and conservation whereas fit out is not currently seen as impacting on fabric and being solely ‘decoration’. This research also highlights the issue of giving advice on u-value targets or limits as apart from Rsi all the calculations in figure 2 use the same wall build up with significantly different results.

Reference

[1] DIN-Fachbericht 4108-8:2020-09 Thermal insulation and energy economy in buildings - Part 8: Avoidance of mould growth in residential buildings

[2] BS EN ISO 6946:2017 Building components and building elements - thermal resistance and thermal transmittance - calculation method

[3] BS EN ISO 13788:2012 Hygrothermal performance of building components and building elements - Internal surface temperature to avoid critical surface humidity and interstitial condensation - Calculation methods (ISO 13788:2012)

[4] BS EN ISO 10211:2017 Thermal bridges in building construction - heat flows and surface temperatures - detailed calculations

[5] BS EN 15026:2007 Hygrothermal performance of building components and building elements - assessment of moisture transfer by numerical simulation.

[6] BS 5250:2021 Management of moisture in buildings, Code of practice