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External Thermal Insulation Composite Systems (ETICS)

An Evaluation of Hygrothermal Behaviour

Springer

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Preface

External Thermal Insulation Composite Systems—ETICS are nowadays often used in Europe. Despite its thermal advantages, low cost and ease of application, this system has serious problems of biological growth, causing the cladding defacement. Although no changes occur in the thermal and mechanical performance of the system, biological defacement has an enormous aesthetic impact, which gathers the building's dwellers' disapproval, thus restricting full implementation of this technology.

The most important goal of this publication is to assess the hygrothermal behaviour of façades covered with ETICS as the main cause of biological growth and present a methodology to estimate the risk of defacement that can be used as a decision support tool. Its special features are: (a) 1-year experimental test campaign results; (b) methodology to assess the hygrothermal behaviour; (c) sensitivity analysis of hygrothermal behaviour based on numerical simulation and (d) evaluation of obstacles influence.

The main benefit of this book is to compile information on ETICS hygrothermal behaviour, as almost no information is available on this topic. It will also add new findings achieved by the authors and will highlight key aspects to be considered when applying ETICS, for practitioners, or when studying hygrothermal behaviour of ETICS, for researchers or students. It will also provide a decision support tool for avoiding undesired hygrothermal behaviour, which may be very interesting for those who intend to apply the system.

The authors would like to acknowledge their gratitude for the support received from the University of Porto—Faculty of Engineering, Portugal, and from the Building Physics Laboratory (LFC). Finally, the authors would welcome readers' comments, corrections and suggestions with the aim of improving any future editions.

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Contents

Symbols and Units

BIO.MOD1	Humidification index related with condensation (–)
BIO.MOD2	Humidification index related with rain (–)
BIO.MOD3	Humidification index related with condensation and rain (–)
CP	Condensation Potential (Pa)
CPd	Condensation Potential in degrees (°C)
CPE	Condensation Potential Equivalent (Pa h)
CPEd	Condensation Potential Equivalent in degrees (°C h)
D_ϕ	Liquid conduction coefficient (kg/m s)
DP	Drying Potential (Pa)
DPE	Drying Potential Equivalent (Pa h)
F_{atm}	Atmospheric field of view (–)
F_{HO}	View factor between the horizontal obstacle and the surface (–)
F_{VO}	View factor between the vertical obstacle and the surface (–)
F_{ter}	Field of view of the ground (–)
h	Distance between the vertical obstacle and the surface (m)
h	Horizontal obstacle depth (m)
h_v	Evaporation enthalpy of the water (J/kg)
I_e	Long wave radiation emitted by the surface (W/m^2)
I_l	Long wave radiation arriving to the surface (W/m^2)
I_{atm}	Downward atmospheric radiation (W/m^2)
I_{ter}	Long wave radiation emitted by the ground (W/m^2)
I_s	Solar radiation arriving to the surface (W/m^2)
$I_{s,\text{dif}}$	Diffuse solar radiation normal to the surface (W/m^2)
$I_{s,\text{dir}}$	Direct solar radiation normal to the surface (W/m^2)
$I_{\text{VO(inc)}}$	Vertical obstacle radiation that reaches the façade (W/m^2)
$I_{s,\text{ref}}$	Solar radiation reflected by the ground (W/m^2)
p_{sat}	Water vapour saturation pressure (Pa)
P_{sat}*(surface)*	Water vapour saturation pressure on the surface (Pa)
P_v*(air)*	Water vapour partial pressure in the air (Pa)
R_h	Horizontal rainfall amount (mm/h)

R_1, R_2	Driving rain coefficients
T	Temperature (K)
T_{dp}	Dew point temperature (°C)
T_s	Surface temperature (°C)
T_{surf}	Surface temperature (K)
v_{wind}	Wind speed (m/s)
v_{10}	Reference wind speed at 10 m above ground (m/s)
w	Moisture content (kg/m^3)
w	Width of the obstacle (m)
w	Façade height (m)
WDR	Wind-driven rain intensity (mm/h)
$WDRPE$	WDR Potential Equivalent (Pa h)

Greek Letters

α_c	Convective heat transfer coefficient (W/m^2 K)
α_s	Short wave absorptance (–)
β	Moisture transfer coefficient (m/s)
δ_p	Water vapour permeability (kg/m s Pa)
ε	Long wave emissivity (–)
θ	Angle between the wind direction and the normal to the façade (º)
λ	Thermal conductivity (W/m K)
ρ_{ter}	Long wave radiation reflectivity of the ground (–)
σ	Stefan–Boltzmann constant (5,67 $\times$ 10^{-8} W/(m^2 K^4))
ϕ	Inclination of the surface (º)
ϕ	Relative humidity (%)