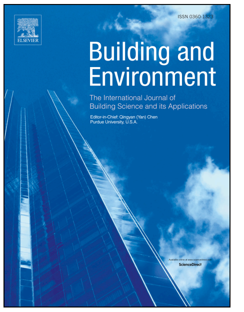
Accepted Manuscript



Prediction model of microclimatic surface conditions on building façades

Stergiani Charisi, Thomas K. Thiis, Petter Stefansson, Ingunn Burud

PII: S0360-1323(17)30524-3

DOI: 10.1016/j.buildenv.2017.11.017

Reference: BAE 5170

To appear in: *Building and Environment*

Received Date: 8 August 2017

Revised Date: 9 October 2017

Accepted Date: 12 November 2017

Please cite this article as: Charisi S, Thiis TK, Stefansson P, Burud I, Prediction model of microclimatic surface conditions on building façades, *Building and Environment* (2017), doi: 10.1016/j.buildenv.2017.11.017.

Prediction model of microclimatic surface conditions on building façades

Stergiani Charisi*[1], Thomas K. Thiis[1], Petter Stefansson[1], Ingunn Burud[1]

[1]Faculty of Science and Technology, Norwegian University of Life Sciences, 1430, Ås, Norway

ABSTRACT

The microclimatic surface conditions of a building façade are critical for determining the degradation of the façade material. Most models use the ambient temperature and RH to predict mould growth and decay on building materials. On the other hand, Heat, Air and Moisture (HAM) simulation software able to calculate the surface conditions, treats the whole façade uniformly without including architectural characteristics of the façade, such as window sills or overhangs, which can have shadowing effect. A simulation model that takes into consideration both the local microclimate and the spatial architectural characteristics of the façade has been developed to predict the spatial surface temperature and moisture content over a whole façade. The model is validated through measurements for two different building façades – wooden consisting of aspen (*Populus tremula*) and masonry consisting of red fire clay bricks. The measurements include monitoring of the spatial surface temperatures with an infrared camera, and logging of the surface moisture content of selected points on the façade using wood resistance humidity sensors. The validation shows that the simulation model can predict the microclimatic surface conditions with high accuracy and can sufficiently capture the spatial variations of surface temperature and moisture content over a building façade.

Keywords: microclimate, façade, surface temperature, moisture content, thermography

1. INTRODUCTION

Contemporary architectural trends tend to use sustainable materials. Untreated wood is continuously gaining in popularity as façade cladding, while red fire clay bricks remain a traditionally safe aesthetical choice for exterior façades. However, such materials are susceptible to degradation caused by the natural weathering process. One of the main degradation problems caused to porous materials, such as wood and brick, is the potential mould and algae growth [1,2]. Especially for untreated wood, the possibility of discoloration by sunlight is additionally introduced [2]. In addition, the frost decay of porous materials creates a severe concern, especially in cold climates [3].

Extended research studies show that the driving mechanisms for biological growth on building materials are the hygrothermal conditions [1, 4-9]. Some of the mathematical models for mould growth consider only the climate conditions for temperature and RH, neglecting the surface conditions of the material [4,5], while others use HAM simulation tools to calculate the surface temperature and moisture [1]. All scientific findings though highlight the importance of fluctuations on moisture and temperature conditions, as they can enhance or delay the biological activity on the material surface [5-7].

Furthermore, plenty of scientific reports study the impact of urban and local microclimate on building performance, and promote the coupling of microclimate models with building performance simulation [10-12]. Although microclimatic weather conditions have been mostly linked with the building energy, they can also significantly affect the hygrothermal performance of a building. This local microclimate can significantly impact the surface temperatures of building façades and the air temperatures around a building [13]. It also defines the amount of solar radiation and wind-driven rain that impinges on the building façades, which are crucial factors for the degradation of building materials. In addition, the various architectural details of exterior façades, such as window sills or overhangs, will create local areas