Available online at www.sciencedirect.com

ScienceDirect

Procedia Environmental Sciences 38 (2017) 397 – 404

Procedia Environmental Sciences

International Conference on Sustainable Synergies from Buildings to the Urban Scale, SBE16

Analysis of the Thermal Bridging Effect on Ventilated Facades

T.Theodosiou[a,*], K.Tsikaloudaki[a], D.Bikas[a]

[a]*Laboratory of Building Construction and Building Department of Civil Engineering, Aristotle University of Thessaloniki, P.O. Box: 429, Gr-54124 Thessaloniki, Greece*

Abstract

Resent developments on the requirements regarding the thermal efficiency of buildings and building envelopes, have increased the need for energy retrofit of building envelopes. Cladding systems and ventilated facades are among the most attractive solutions to these problems due to a variety of reasons, including aesthetics, moisture control, serviceability and resistance to environmental factors. Despite all the benefits of these structures, their actual thermal efficiency has not been studied extensively yet. In many countries, the thermal performance of these structures is treated in the same way as more simple structures like ETICS. Within the framework of the European project E2VENT, an thorough study of the nature of thermal bridges has been performed – among others- in order to reveal the nature and the magnitude of thermal bridge effects in such structures, to investigate the design parameters that can assist in minimising their contribution in overall heat flows and to improve the overall thermal efficiency of the building envelope. Results shows that thermal bridges in metal cladding systems can be a significantly weak point in thermal insulation protection if no special care is given during the design and the construction process. By simply neglecting point thermal bridges due the lack of specific requirements, to the insufficient knowledge or by considering that only the use of thermal-break products can efficiently treat it, can significantly decrease the thermal insulation quality of the façade, leading to undesirable results.

Peer-review under responsibility of the organizing committee of SBE16.

Keywords: Thermal bridges; aluminum cladding; building façade; thermal insulation

1. Introduction

Ventilated building facades are an external envelope technique with significant benefits over traditional, single skin facades. These benefits cover almost all building physics topics, from moisture to thermal efficiency, noise, fire

* Corresponding author. Tel.: +30-2310-995818; fax: +30-2310-995603
E-mail address: tgt@civil.auth.gr

Peer-review under responsibility of the organizing committee of SBE16.
doi:10.1016/j.proenv.2017.03.121

resistance and structural efficiency. Aluminium cladding systems, are a special case of ventilated facades, presenting some additional benefits that have highly promoted their penetration, especially into the building retrofit marker. These lightweight structure is considered to be a sustainable construction system since it is almost fully recyclable, it promotes external thermal insulation using more environmental friendly thermal insulation materials and it minimizes linear thermal bridges that can account for a large portion of thermal losses through the building envelope [1,2]. Recent developments in European building requirements regarding the energy efficiency of buildings, are promoting the use of such system in numerus building energy retrofit projects. In this context, improving the efficiency of this technique can lead to more efficient buildings. This is one of the main goals of the E.U. funded project E2VENT: Energy Efficient Ventilated Façades [3]. Within the framework of E2VENT, a Smart modular heat recovery unit (SMHRU) and a latent heat system for thermal storage (LHTES) are integrated within the cladding system in order to provide a holistic, and yet, simple and sustainable solution for the energy upgrade of existing buildings. The cladding system is optimized by means of thermal, and structural efficiency, in order to develop characteristics specially for the retrofit of existing buildings.

In most EU member states, the thermal efficiency of metal cladding systems is treated similarly to traditional single skin envelopes. Thermal bridge effects are taken into account, but only those that have the form of linear thermal bridges. Point, or 3-dimensional thermal bridges, are usually neglected since, their effect on heat flows through the building envelope is considered to be very small, and extremely difficult to estimate, since such calculations are based on analytical finite-element analysis tools, not suitable for studies in the construction industry. In the absence of special legislations and requirements regarding the treatment of these constructions, it is quite common to overlook the existence of this effect, not only during the design stage but also during the construction phase.

While in traditional building envelopes, the magnitude of point thermal bridges is of minor importance, this is not the case in double-skin facades. These constructions require a relatively large number of points where the external envelope has to be secured on the internal-substrate envelope. At these areas, steel or aluminium brackets, penetrate the insulation layer. Although the volume of the brackets is extremely small compared to the one of the insulation layer, its thermal transmissivity can be more than 2000 times higher, leading to intense thermal bridge heat flow between the warm interior wall behind the thermal insulation and the cold structural metal frame in winter and via-versa in summer. Recent studies show that overlooking point thermal bridges is such constructions can lead to more than 20% underestimation of the actual heat flow magnitude, depending on a variety of factors [4].

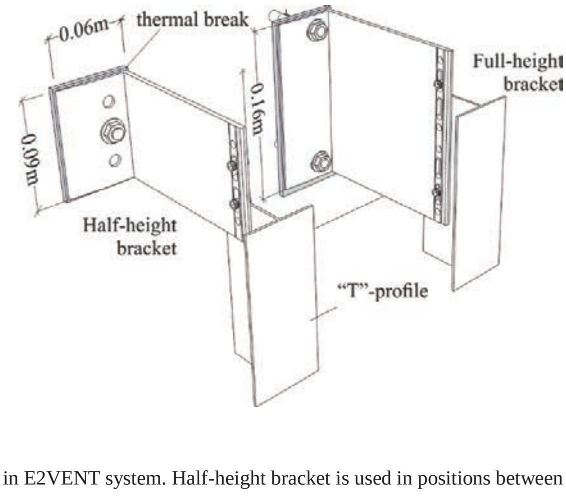

Figure 1. Sketch of the brackets used in E2VENT system. Half-height bracket is used in positions between floors and full height brackets in positions at floor level

Within the framework of the E2VENT project, a lot of effort was invested on studying in detail the point thermal bridge problem of the system under development. The main goal is to investigate the nature of thermal bridge