Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 181 (2017) 682 – 689

Procedia Engineering

www.elsevier.com/locate/procedia

10th International Conference Interdisciplinarity in Engineering, INTER-ENG 2016

The Influence of Thermal Bridges in the Process of Buildings Thermal Rehabilitation

Laura Dumitrescu[a,]*, Irina Baran[a], Radu Aurel Pescaru[a]

[a] *"Gheorghe Asachi" Technical University of Iași, Str. Prof.dr.doc. Dimitrie Mangeron nr. 1, mun. Iași, 700050, Romania*

Abstract

The energy efficiency is a top priority of the construction sector. For this reason, many buildings are undergoing a process of thermal rehabilitation in order to reduce their energy consumption. But for high energy performance and well insulated building envelopes, the influence of thermal bridging on the building energy consumption is major. The aim of the paper is to assess the influence of thermal bridges in the process of thermal rehabilitation, using numerical modelling of the thermal field and thermal bridge catalogues.

Peer-review under responsibility of the organizing committee of INTER-ENG 2016

Keywords: Energy efficiency; Thermal insulation; Thermal bridging.

1. Introduction

We live today in an era of technology, when mankind is experiencing significant improvements in all sectors of life. It is a period of important changes due to the application of new science and technology results. Thus, goods which at a time were considered to have very good performances, after a while they become morally outdated before they are physically outdated. So, they must be replaced, or their performances must be improved. The buildings sector is a very special one, because they are designed to be used for a long time.

The overall building stock in Romania is constructed mostly in the 1960-1990 period, made with low thermal insulation, as a consequence of the energy crisis of 1973. The envelope of these buildings presents a low level of

* Corresponding author. Tel.: +40-232-278680 ext. 1497; fax: +40-232-233368.
E-mail address: laura.dumitrescu@gmail.com

Peer-review under responsibility of the organizing committee of INTER-ENG 2016
doi:10.1016/j.proeng.2017.02.450

protection against heat loss, which is no longer acceptable according the recent energy efficiency regulations. Besides the residential sector, the public buildings are also an important consumer of energy [1].

As this sector is the most important consumer, representing 40% of the European Union's total energy consumption, increasing energy efficiency in this area is therefore a priority. So, many buildings are undergoing a process of thermal rehabilitation in order to reduce their energy consumption. To improve energy efficiency of the existing buildings is essential, not only for achieving national objectives of energy efficiency in the medium term, but also to meet long-term objectives of the strategy on climate change and the transition to a competitive economy with a low carbon dioxide emission by 2050 [2, 3].

The evaluation of energy use in buildings requires an accurate assessment of heat transfer through the building envelope, which includes the heat passing through thermal bridges. A thermal bridge, also called a cold bridge or heat bridge, is an area of a building which has a significantly higher heat transfer than the surrounding materials resulting in an overall reduction in thermal insulation of the building. Thermal bridges occur in three ways, through: materials with higher thermal conductivity than the surrounding materials, penetrations of the thermal envelope, and discontinuities or gaps in the insulation material. To assess with sufficient precision the extent to which they intervene, it is necessary to identify, with the best possible accuracy, the physical and geometrical configuration of these areas and to determine linear coefficient of heat transfer by numerical simulations of temperature field [4, 5].

Not all European countries consider the influence of thermal bridges in their regulations for new buildings and even less for the renovation of the existing ones, because the correct calculation of linear thermal transmittance is quite laborious. However, buildings can contain significant thermal bridges, their total impact on the heating energy need is in general considerable.

The present paper highlights a study concerning some specific aspects regarding the identification of thermal bridges, the evaluation of these heat losses and their effect on the overall building performance. Reduced energy consumption and increased use of renewable energy have an important role in promoting security of energy supply and technological developments.

Nomenclature

U'	adjusted thermal transmittance of each different building envelope element [W/ m^{2}K];
U	regular thermal transmittance (heat transfer coefficient) of the building envelope element [W/ m^{2}K];
R'	adjusted thermal resistance of the building element (thermal bridge effects are included) [m^{2}K/W];
R	specific unidirectional thermal resistance related to the element of area A [m^{2}K/W];
r	reduction coefficient of the specific unidirectional thermal resistance, $r = R'/R$ [-];
ψ	linear thermal bridge heat transfer coefficient [W/mK];
χ	punctual thermal bridge heat transfer coefficient [W/K];
l	length of linear thermal bridges from the building element with area A [m];
θ_{si}	interior surface temperature of a building element [^{o}C];
f_{Rsi}	temperature factor, the difference between the interior surface temperature θ_{si} of a component and outdoor air temperature θ_e, related to the difference of temperatures between indoor air θ_i and outdoor air θ_e [-];
T_{si}	dew point temperature [^{o}C];
A	area of the building envelope element with a specific thermal resistance [m^2];
V	heated volume [m^3];
τ	temperature correction factor, the difference between the indoor air temperature θ_i and the temperature of an unheated space θ_u, related to the difference of temperatures between indoor air θ_i and outdoor air θ_e [-];
G1	global coefficient of thermal insulation [W/m^{3}K];
G1ref	reference global coefficient of thermal insulation [W/m^{3}K].