Energy and Buildings 85 (2014) 631–637

Contents lists available at ScienceDirect

Energy and Buildings

journal homepage: www.elsevier.com/locate/enbuild

VIP as thermal breaker for internal insulation system

H. Sallée [a], D. Quenard [a,*], E. Valenti [b], M. Galan [c]

[a] CSTB, Centre Scientifique et Technique du Bâtiment, 24 Rue Joseph Fourier, 38400 Saint Martin d'Hères, France
[b] PLATEC, ZA Bavière Dauphine, Colombe 38690, France
[c] SAITEC, ZI 5 Bd Pascal, BP 177, Challans Cedex 85303, France

ARTICLE INFO

Article history:
Available online 30 August 2014

Keywords:
Vacuum insulation panels
Thermal breaker
Retrofitting
Energy savings

ABSTRACT

Building renovation is a major challenge in Europe with more than 200 million of existing buildings to renovate. Generally, ETICS (External Thermal Insulation Complex System) is claimed as being the most efficient system especially for tackling thermal bridges and keeping thermal inertia. Nevertheless, this system cannot be applied to some existing buildings, especially those having a façade with a high architectural character. In this communication, a slim thermal breaker (STB) for indoor use, made of a VIP protected with PU foam and a finishing board, is presented. A mock-up has been built up in order to investigate the efficiency of the thermal breaker for partition wall. The experimental results and the simulation have shown that the use of this slim thermal breaker (STB) yields a reduction of around 30% of the whole *U*-value whereas a reduction of 50% is obtained using ETICS.

1. Introduction

Building renovation is a major challenge in Europe with more than 200 million of existing buildings [1]. More than half of them were built before the first major oil crisis, in 1973, an era where there was little or no consciousness of the need to design for energy efficient performance. A large part of this existing stock need to be insulated and building envelope [2] is of high priority to achieve energy efficiency. Indeed, several studies [3,4] have shown that the most efficient way to curb the energy consumption in the building sector remains the reduction of the heat loss by improving the thermal insulation of the building envelope (roof, floor and wall). Generally, ETICS (External Thermal Insulation Complex System) [5] is claimed as being the most efficient system especially for tackling thermal bridges and keeping thermal inertia from external walls. Nevertheless, ETICS cannot be applied to some existing buildings, especially the 12 million of residential multi-storey buildings with distributed ownership. Indeed, these buildings often present interesting features from the architectural and structural point of view, often having a façade with some 3D architectural patterns, especially in cities.

Furthermore, in existing building, thermal bridges represent a significant share of heat losses through building envelope. They account for about 5–10% of the total heat losses of building, air-ventilation included, and more than 40% of heat losses through a vertical wall. They are also the source of a lot of pathologies due to high relative humidity and moisture condensation resulting to lower temperatures at the intersection between vertical walls and ceiling, floors or partition walls.

In order to meet the requirements of the European Thermal Regulation, many thermal breakers [6] have been developed for new buildings but technical solutions for existing buildings are still missing. Super Insulating Materials, such VIP's [7], appear as good candidates but due to their specific properties and technical characteristics they cannot be implemented directly on site without drastic recommendations and a continuous supervision during the works. Therefore, two types of slim thermal breaker (STB) have been developed by integrating a VIP panel in protective shell made of PU foam on one side and plasterboard or a high density PU on the other one.

2. Design of the slim thermal breaker (STB)

The internal thermal breaker concept is presented in Fig. 2 and the geometrical characteristics (length and thickness) of this system have been defined through thermal modelling, carried out with the software HEAT 2D [8]. The simulation scheme considers the connection between an insulated external wall and a partition wall, both made with concrete. Two simplified thermal breakers are installed on both sides of the partition wall (Fig. 1). The cavity and the fastening rails (Figs. 3 and 7) are not taken into account in the simulation. The parametric analysis considered only two cases.

* Corresponding author. Tel.: +33 4 76 76 25 46.
E-mail address: daniel.quenard@cstb.fr (D. Quenard).

http://dx.doi.org/10.1016/j.enbuild.2014.08.039

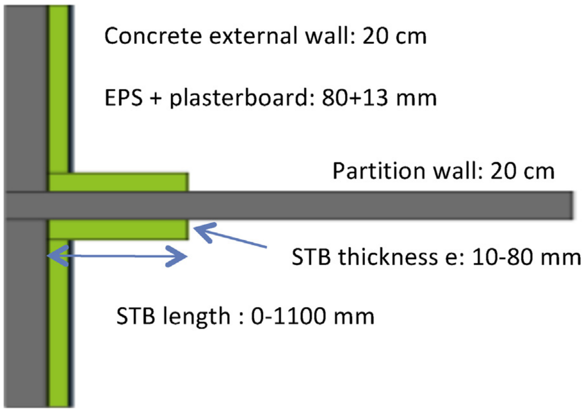

Fig. 1. Concept of the internal thermal breaker.

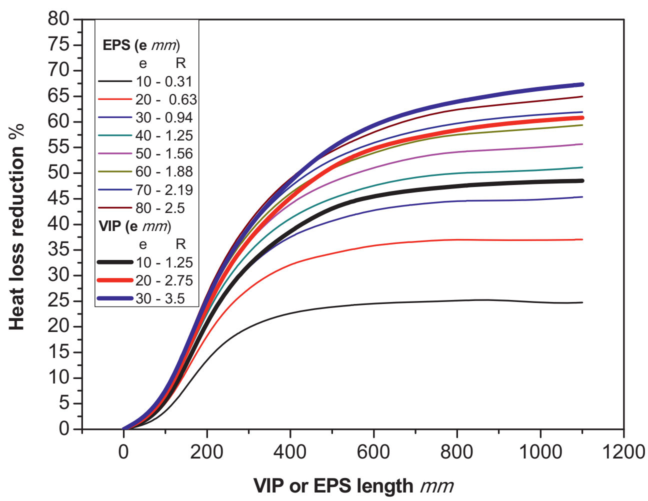

Fig. 2. Design of the slim thermal breaker (STB) – length & thickness of the VIP.

Table 1
Material description & properties.

Materials	Thickness (cm)	Thermal conductivity ($W\,m^{-1}\,K^{-1}$)
Concrete wall (Figs. 1 and 2)	20	2
Concrete blocks filled with poured concrete (Mock-Up)	15	1.7
EPS insulation	8	0.032
Plasterboard	1.3	0.3
VIP	2	0.008
PU foam	2	0.022
High density PU	1.3	0.028

The first one is made of traditional EPS foam with a thickness varying from 10 to 80 mm (thin lines in Fig. 2) whereas the second one is made of a composite multilayer system: a PU foam layer, a VIP and a plasterboard. The properties of the three materials are given in the Table 1. Three VIP thicknesses have been tested: 10, 20 and 30 mm (thick lines in Fig. 2).

In Fig. 2, the reduction of the linear transmission coefficient ψ, initially equal to 0.77 $W\,m^{-1}\,K^{-1}$, is presented versus the type, the length and the thickness of the insulating materials. The computation shows that a pseudo-asymptotic value is reached with a length of about 1100 cm. With 8 cm of EPS or 3 cm of VIP the heat loss reduction is around 65%. In order to reduce the sizes (length & thickness) of the VIP panel and consequently the price of the STB, a VIP thickness of 20 mm and 700 mm length has been selected. These values yield a reduction of the linear transmission coefficient ψ about 55% of the heat loss through the thermal bridge. Indeed, an increasing of the VIP length by 10 cm only reduces the heat loss only by 1.5%.

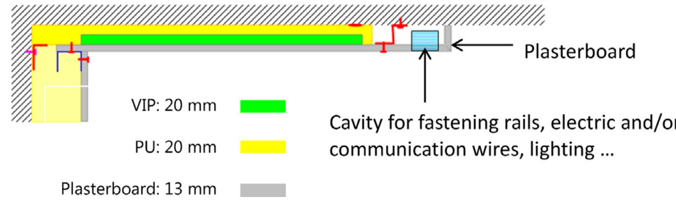

Fig. 3. Scheme of the STB for ceiling implementation.

Fig. 4. Photography of the STB for ceiling implementation.

3. Manufacturing and implementation testing

Two types of slim thermal breaker (STB) have been developed, one for ceiling applications (cornice type – Figs. 3 and 4) and another for floor implementation (Figs. 5 and 6). Considering the fragility of VIP, mainly the risk of punching during handling and implementation, both thermal breaker concepts have been designed as a multilayer composite systems. They are made of a VIP which is protected on the hindered side by PU foam and on the visible side either by plasterboard for the ceiling STB (Figs. 3 and 4) or by high-density PU foam for the floor STB (Figs. 5 and 6), in order to offer a traditional surface finishing.

The geometrical characteristics and the thermal properties of both STB are summarised in Table 2. The thermal resistances of