



Efficiency verification of a combination of high performance and conventional insulation layers in retrofitting a 130-year old building

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ABSTRACT

The performance and applicability of a newly developed high efficiency insulation material to retrofit old buildings was investigated in a pilot project supported by the Swiss Federal Office of Energy (SFOE). One half of an old stone walled building situated in the city of Zurich dating from 1877 has been retrofitted by means of a high efficiency thermal insulation layer of 20 mm thickness containing aerogel on the external side, and a conventional insulation material of 20 mm on the inner side of the stone walls. This procedure promised a theoretical reduction of the steady state *U*-value of the wall by approximately a factor of 3 without compromising the original appearance of the building. To verify this, in-situ measurement of the *U*-value as well as infrared thermography has been performed during the cold weather period of early 2011 when there was a large temperature gradient between indoor and outdoor climate.

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1. Introduction

The stock of residential buildings constructed before the 1970s which have low performance regarding energy saving makes up more than 3/4 of the total existing residential buildings in European countries [1]. Correspondingly many efforts have been undertaken to retrofit such buildings in the past few years and are still going on. Among others the FP7 Cooperation Work Programme of the European Community has allocated a budget of EUR 140 million in 2012 for the “Energy Efficient Buildings Initiative” [2]. The issue of retrofitting becomes more complex for listed historical buildings with additional tight requirements to keep their outer façade unchanged and the overall appearance of the surroundings unaffected by retrofit measures. Adding conventional layers of 8 to 10 cm thickness for an effective reduction in energy consumption causes a number of practical problems when applied internally or externally to an old listed building. The appearance of high performance thermal insulation products on the construction market with thermal conductivities lower than 25 mW/mK has opened new perspectives in retrofitting listed buildings.

The building used for the present investigation has solid stone walls, dates from 1877, and is one of a number of semi-detached houses (Fig. 1) forming a small district in the city of Zurich, Switzerland. There was a strict requirement regarding the overall appearance of the building and its position among the neighbouring buildings to remain unchanged. The aim was to significantly reduce the overall energy consumption. As a pilot project different measures were taken to reach this goal only for one half of such a double-house. The roof and the floor above the cellar were insulated by means of conventional mineral wool. However, for the outer façades a thick insulation was not applicable due to structural changes which would violate the above requirement on the one hand and applying it as an interior insulation on the other hand would have reduced significantly the size of the already small rooms. A solution was found by using 2 cm of a high performing fibre insulation mat containing aerogel which allows a reduction in thickness (by a factor of 2–3) compared to conventional insulation materials, together with an insulation rendering to be installed on the external side and a conventional insulation of 2 cm of expanded polystyrene (EPS) on the inner side of the stone walls. It has to be kept in mind that the price of high efficiency thermal insulation compared to the conventional material with the same thermal resistance is still higher by a factor of 4. By adding these two insulation layers on both sides of the old stone wall it was expected to reduce the total thermal transmittance (*U*-value) to 0.48 W/(m² K)

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