First-generation Low-energy Buildings

Quality of the Thermal Envelope

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Published in:
Proceedings of the 5th International Building Physics Conference

Publication date:
2012

Document Version
Accepted author manuscript, peer reviewed version

First-generation Low-energy Buildings: Quality of the Thermal Envelope

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Keywords: thermal envelope, quality, low-energy, building, evaluation, thermographic observations, on location

ABSTRACT

The paper focuses on the thermal envelope of buildings. In Denmark, the energy consumption of buildings is estimated to nearly 50% of the national energy production. Energy is used for hot water, heating and comfort and plays a very important role in the endeavour to limit emission of greenhouse gases and to comply with the Kyoto Protocol. As a consequence, energy provisions in the Danish Building Requirements have been tightened twice over the last five years. Each tightening was estimated to result in an energy reduction of 25% for new buildings. The tightened energy provisions paved the way for further tightening in 2015 and 2020. Each tightening is expected to result in a 25% energy reduction. In the work to reduce the energy consumption of buildings, it is important to ensure that buildings comply with the energy provisions. Buildings comply with the energy provisions by decreasing the average coefficient of heat transmission, the U-value, and by reducing air leakage of the thermal envelope combined with technical solutions for heat recovery and energy supply. At the introduction of low-energy buildings, it is important that the heat loss through the thermal envelope is reduced both in the design and in practice when constructing the building. Therefore, it is important to assess whether the quality of the construction of the thermal envelope complies with specifications outlined in the design descriptions of these buildings.

The thermal envelope of nine first-generation low-energy buildings constructed as individual dwellings built in Denmark between 2006 and 2008 was visually observed by means of thermographic equipment. Measurements showed the quality of the work carried out on location. During winter, the exterior walls were observed by means of commercially available thermographic equipment. The performance was assessed on the basis of these on-location studies. The investigation covered a real-life situation where the inhabitants and normal weather conditions influenced the thermal insulation. The paper evaluates the selected solutions carried out both to achieve a high-performance thermal envelope and to prevent thermal bridges.

1. Investigations

The thermal performance of high-performance exterior walls was investigated to uncover any failures in the thermal performance i.e. thermal bridges, cavities without thermal insulation and incorrect insulation work. The investigation was carried out using commercially available thermographic equipment.

All the investigated dwellings passed the air permeability test measured by using the method described in DS/EN 13829 and ISO 9972:2006.

2. Results

Thermographic observations revealed lower thermal performance at the thermal envelope locally. These were seen as local areas in the thermal envelope with a lower temperature than at the overall surface of the thermal envelope. The thermographic observations were divided into seven categories describing the types of failure observed.

Measurements were carried out by analysing thermographic digital pictures in colours. Temperatures were measured by means of the colour scale in each picture and by using a PC.

Category number six, of seven categories, shows cold areas in the thermal envelope along ceilings. The category includes inhomogeneity in the thermal performance of the thermal envelope at the ceiling. A thermographic picture illustrates a failure as the result of gaps in the joint between the wind barriers, see figure 1.

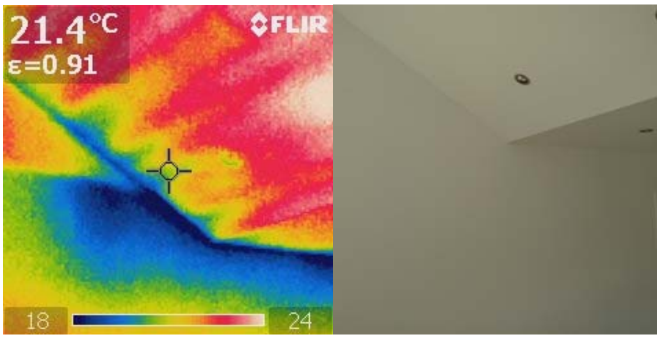

Figure 1. On the thermographic picture to the left, the dark blue colour represents 18 °C and the light red colour represents 24 °C. The picture to the right is an ordinary photo.

3. Conclusion

The thermal envelope of first-generation low-energy buildings built between 2006 and 2008 was investigated. Observations revealed the need for quality assurance of the thermal envelope to ensure that high-performance thermal envelopes are constructed to perform with a coefficient of heat transmission as expected and provided at the design stage.

Acknowledgement

The work, on which this paper is based, was supported by the EUDP programme, The Danish Energy Agency.