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Defects of insulation systems and their negative effect on the accumulation and energy saving

Ing. Pavel Vlček[1, a], doc. Ing. Karel Kubečka, Ph.D [2,b],
prof. Ing. Darja Kubečková, Ph.D.[1,c], Bc. Hana Vaculíková[1,d]

[1] VŠB – TUO, Faculty of Civil Engineering, Department of Building Constructions, L. Podéště 1875, 708 33 Ostrava Poruba, Czech Republic

[2] VŠB – TUO, Faculty of Civil Engineering, Department of Building Structures, L. Podéště 1875, 708 33 Ostrava Poruba, Czech Republic

[a]pavel.vlcek1@vsb.cz, [b]karel.kubecka@vsb.cz, [c]darja.kubeckova@vsb.cz, [d]hana.vaculikova@vsb.cz

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Abstract. Defects in heat insulation systems caused by incompliance with technological procedures and by human error in the course of their implementation negatively affect energy accumulation and saving. The result is thermal bridges and lower energy saving than expected in the stage of heat insulation project preparation.

Introduction

The below mentioned defects in implementation of contact heat insulation systems are often affected by human error. You can often come across cases when these systems are implemented by personnel of civil engineering companies without the slightest idea of the problems incorrect implementation of contact heat insulation may case to the building owners in future. Safety of the future building residents can be threatened by reduced fire safety of the constructions.

Board Gluing

The currently effective standards and regulations stipulate requirements for board gluing which in many cases are not complied with by employees of the construction companies. Lack of their systematic observance negatively affects energy accumulation and saving considered in the project preparation stage.
Requirements for board gluing:

- The glue is applied manually or mechanically on the reverse side of the board in the form of a bead along the board perimeter and to the middle either in the form of butts (at least three per board);
- In the case of mechanical application in the form of an irregular bead;
- In the case of ETICS connected to the base with the glue only at least 40% of the foam polystyrene insulation board surface must be glued to the base, unless otherwise specified in the building documentation.

If the above principles are not observed and the insulation boards are glued other than as prescribed by the standards (such as with butts only without the bead along the board perimeter) (Figure 1) thus incorrectly implemented facades can suffer damage. Significant reduction of adhesion and stability may cause destruction of the facade. Incorrectly glued boards can also be subject to cyclic deformations (repeated sagging) causing bulging of the plaster and development of cracks in the points of board contact.
With regard to fire safety of buildings absence of board gluing along their perimeter can reduce fire safety of the structure due to vertical gas flows.
Another important fact is that the developing cold air under the heat insulation boards cools the peripheral construction a negatively affects heat accumulation and energy saving.

Figure 1: Gap between peripheral wall and its heat insulation, incorrect gluing of heat insulation boards

Board Gluing on Circular Sections of Buildings

Due to insufficient training and/or lack of knowledge of employees of construction companies implementing installation of contact heat insulation systems inappropriate types of heat insulation are often used for insulation of circular sections of buildings.

Figures 2, 3: Inappropriate heat insulation of circular sections of building

Edges of individual boards are separated from the wall forming gaps between the wall surface and the insulation agent (Figure 2, Figure 3).
This results in development of thermal bridges. However, this is not the only problem connected with energy saving.
A much gibber problem occurs in the course of plaster levelling. As the wall is circular and cannot be exactly levelled by grinding, the layer is thicker in places. This also results in thermal bridges, with subsequent increase of relative humidity in the interiors, development of wet maps ad mould. In such cases the surface finishes of the construction can be damaged or completely degraded, the change of contact thermal insulation material properties happens. Thermal bridges could negative incluence the inner microclimate. [1], [2]

For that reason it is better to use mineral wool with perpendicular fibre which easily follows the construction shape and can be ground to made a level surface, which eliminates problems caused by application of polystyrene.

Window and Door Opening Treatment

Window and door openings are usually larger than the designed windows and doors to be installed in them. The resulting gap between the opening and the reveal is filled mostly with PUR foam. The gap should be 2 - 3 cm.
Larger gaps are not unusual, often up to 10 cm. (Figure 4)

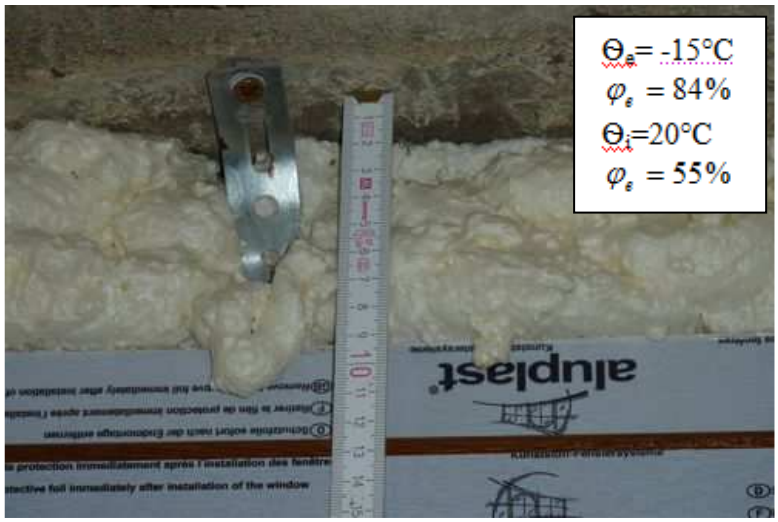

Figure 4: Gap size between the window and the reveal 10 cm.

In this case air humidity is the issue. Air humidity takes the form of vapours both in the interior and in the exterior. When the existing non-tight windows are replaced with perfectly sealing heat insulated window systems humidity increases especially in the warm interiors. The humidity can be absorbed by the construction. The absorbing constructions include polyurethane assembly foam which is used for filling connection gaps. Connecting gap is a place where the window in anchored to the wall. The gap also represents the transition of the window opening to the masonry of the wall. The user places maximum demand on thermal technical requirements for these spaces.
In winter vapours condense in the PUR foam layer on the cold side of the connection gap towards the exterior due to cooling, which reduced heat insulating properties of the joint. As a consequence of non-ventilated humidity on the interior side of the connection gap heat loss and mould develop.

Anchoring of Heat Insulation with Dowels

Many heat insulated facades with thick insulation layer often develop stains in the dowel area after nights when the temperature drops close to zero. As a consequence of heat exchange by radiation hoarfrost results. The hoarfrost does not develop on the dowels, though (the dowels create thermal bridges). The issue of dowels revealed in the visible surface of plaster (popularly called the "dalmatine" effect) (Figure 5, Figure 6) is a condition when under certain temperature and humidity conditions the facade reveals the points where the dowels are anchored. A correctly installed dowel is slightly pressed into the heat insulation for the dowel disc to be flush with the heat insulation layer surface. Even this installation causes that in the place of the dowel there is matter with higher heat accumulation properties under plaster than in the surroundings of the dowel position.

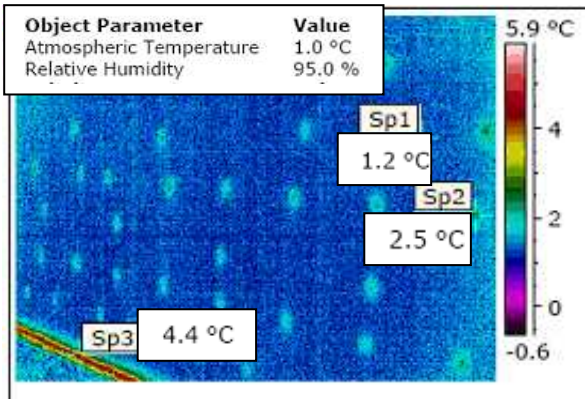

Figure 5, 6: Stains on heat insulation system in the points of dowel anchoring, wall thermogram

Possibilities of problems elimination:

On the base of thermographic measurement and numerical modelation of thermal and moisture fields are possible solution procesures:

The dismantling of current ETICS and replacement with new one with elimination of thermal bridges.

This variant is possible in case of existing layers remove and by usage of wall plugs reducing the thermal bridge (i.e. swage wall plug with cover, wing embedment wall plug). However the damage of current constructions could happen (masonry breeze blocks, damage of placed opening fillings).

The exchange of earlier wall plugs with new with reduced thermal bridge:

By this variant there is considered mechanical remove of current wall plugs (thermografical localization and extraction. Designed wall plugs have to ensure the reduction of thermal bridge (i.e. swage wall plug with cover, wing embedment wall plug). In the case of isolation damage as a result of wall plugs extraction must by this place repaired with insert of the same tape isolation. The hole caused by exciting of the wall plug has to be extended on each side minimally of 50 mm.

Additional isolation layer:

The attitude to the solution is the variant, where another Etisc layer will be applied on the current construction. Additionally made system will only glued by the PUR foam.

Summary

The project preparation stage is important for implementation of contact heat insulation systems of buildings but the actual implementation stage is not less important for subsequent correct functioning of the system. This is conditioned by compliance with all effective technological standards and regulations and absence of human error. Incompliance with the relevant principles not only increases economic costs of potential rehabilitations and reconstructions but also negatively affects the building residents using the incorrectly heat insulated buildings.

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