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THE CONDUCTING OF HEAT IN TIMBER ELEMENTS BY HOT-AIR EXTERMINATION OF INSECTS

VEDENÍ TEPLA V DŘEVĚNÝCH PRVCÍCH PŘI HORKOVZDUŠNÉ LIKVIDACI HMYZU

Abstract

One of the possibilities of wood-borer clean-up in wooden structures (ie. trusses, ceilings etc.) is a dry heat clean-up. The wooden components are heated by a hot air with temperature of 100 to 120°C up until the time, when they reach temperature of 55°C in the entire section for as long as one hour. This article describes concerns relating to the thermal flow at the phase of planning and solution for wooden components that are placed at the structure and that are not exposed to heat from all sides.

Keywords

Rehabilitation of buildings, wooden structure, dry heat clean-up, wood-borer, thermal flow in wooden components, trusses, historical trusses.

Abstrakt

Jednou z možností likvidace dřevokazného hmyzu u dřevěných konstrukcí (např. krovů, stropů apod.) je horkovzdušná likvidace. Dřevěné prvky se ohřívají horkým vzduchem o teplotě 100 až 120 °C až do doby, kdy dosáhnou v celém průřezu teplotu 55 °C po dobu alespoň jedné hodiny. Příspěvek pojednává o problematice řešení vedení tepla v projekční fázi u dřevěných prvků, které z důvodu svého umístění v konstrukci nemohou být ohřívány ze všech stran.

Klíčová slova

Sanace dřevěných konstrukcí, horkovzdušná likvidace dřevokazného hmyzu, vedení tepla v dřevěných prvcích, krovy, historické krovy.

1 INTRODUCTION

One of the possibilities for wood-borer clean-up in timber structures attacked, for instance, by a house longhorn beetle (see Fig. 1) is a dry heat clean-up. This method is used quiet frequently in Germany and has becoming more popular in the Czech Republic. The principle of this method is that the wood borers die if wood components are heated with at least 55 °C hot air along the whole of the cross-section. The heating time should be one hour at least.

The hot air with the temperature between 100 and 120 °C is heated up in special heaters and is injected through a pipe into the air where the wood borers are located - for instance, into an attic (see Fig. 2 and 3).

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Because the wood is little heat conductive only, it is necessary to supply the hot air typically for several hours (depending on the cross-section of wooden components). The temperature is measured continuously in some wooden components which are the least favourable in terms of heat conduction (see Fig. 4). This method consumes rather much energy, but it environment friendly.

The hot air clean-up of wood is carried out by specialist companies. No regulations exist in the Czech Republic that would apply to the design and performance of the clean-up. For instance, WTA [1] can be used as a basis.

Fig. 1: A wooden component attacked by a house longhorn beetle

Fig. 2: Hot air heaters and distribution pipes

Fig. 3: Distribution pipes and the outlet with the remediated area

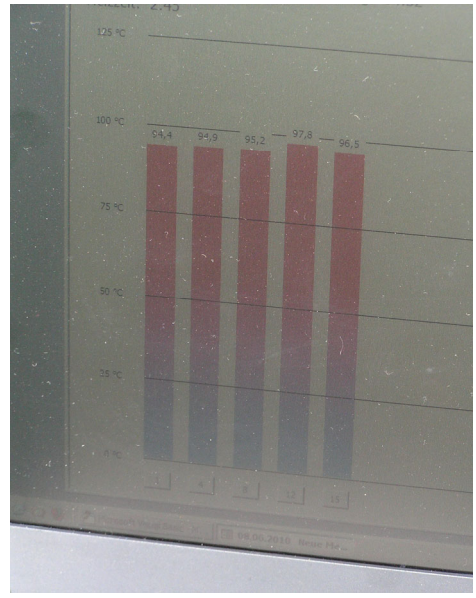

Fig. 4: Temperature measurement results inside certain wooden components

2 ANALYSING THE HEAT CONDUCTION IN TIMBER COMPONENTS

As mentioned above, in order to destroy wood borers, it is necessary to reach 55 °C in all components and in the whole of the cross section. This might be, however, difficult in some components. This is, in particular, the case of the components which will not be heated up with hot air from all four sides. For instance, this is the case of a wall plate placed on the external wall – it is cooled by outdoor air flows. Or heat is removed from the wall plate placed on the outdoor external wall. Other examples are joining beam heads, ceiling joist heads in timber beam ceilings, central or top purlins in rafter connection points, complicated timber binding pieces (see Fig. 5), vertical or horizontal corners in external walls or complete external walls in log walls in old log houses (see Fig. 6).

Fig. 5: A complex timber joint

Fig. 6: A vertical corner in external mades made from timber logs

When preparing the hot air clean-up of the wood borers, it is necessary to pay a particular attention to those timber components which are attacked by the wood borers where it might be difficult to reach 55 °C. The calculation is carried out in AREA 2009 [2] or CUBE 3D 2009 [3], using a 2D and 3D heat field.

If the calculation proves that it is not possible to reach 55 °C for any of the component, another method should be used to destroy the wood borers (for instance, a microwave heating clean-up, or injection of chemicals).

2.1 Examples – heat conduction in timber components

1. A plate wall on the external attic brickwork

Fig. 7 and 8 show development of 2D heat fields during the hot-air clean-up of wood borers in a wall plate. For purposes of comparison, the hot air cleanup described there was performed at outdoor temperatures 25 °C and 5 °C. The temperatures fields in Fig. 7 prove that even in summer it might be very difficult or even impossible to reach 55 °C in the entire cross-section of the wall plate. If the outdoor temperatures are low, this is really impossible.

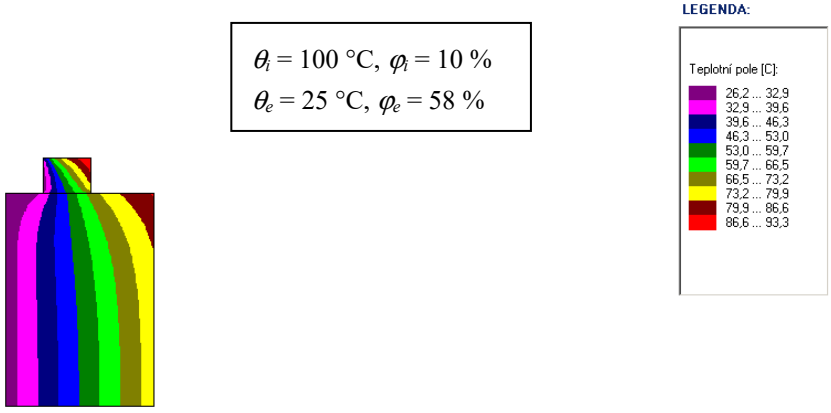

Fig. 7: Development of temperatures in a wall plate an in the adjacent brickword with the outdoor temperature θe = 25 °C. Software: AREA 2009 [2].

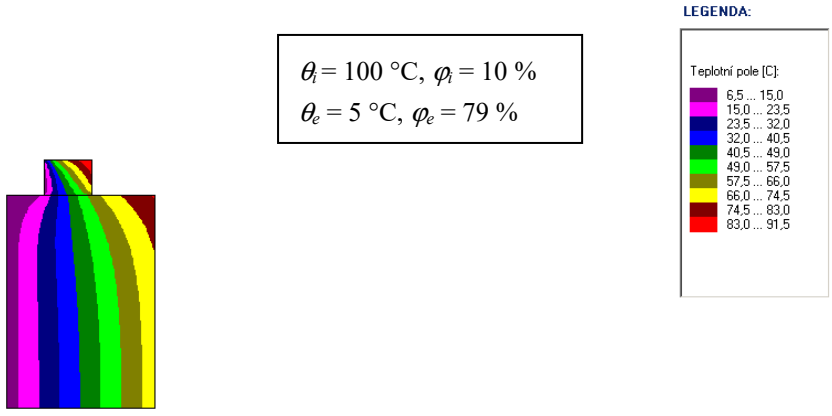

Fig. 8: Development of temperatures in a wall plate an in the adjacent brickword with the outdoor temperature θe = 5 °C. Software: AREA 2009 [2].

2. A vertical corner in an old log house

Fig. 7 and 8 show development of 2D heat fields during the hot-air clean-up of wood borers in a vertical contact corner between the external walls in an old log house. The temperatures fields in Fig. 9 prove again that even in summer it might be very difficult or even impossible to reach 55 °C in the entire cross-section of the corner or along the entire width of the external walls.

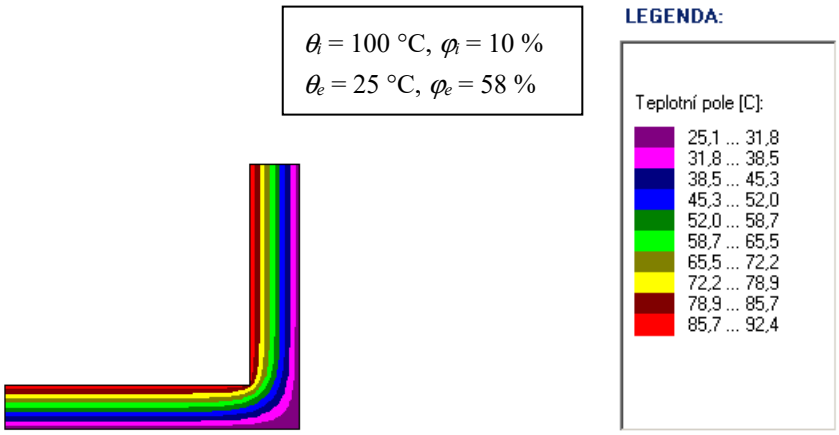

Fig. 9: Development of temperatures in a vertical corner in an old log building with the outdoor temperature θe = 25 °C. Software: AREA 2009 [2].

3. A joining beam on the external attic brickwork

Fig. 10 through 12 shows development of the temperature during the hot-air clean-up of wood borers in a head of a joining beam placed on the external wall. The calculation was performed in CUBE 3D [3].

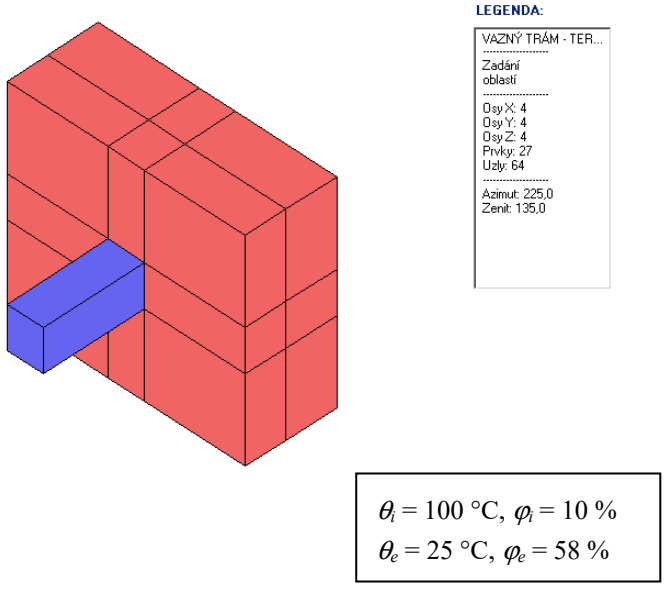

Fig. 10: A calculation model for development of temperatures in the place where a joining beam is located on the external attic brickwork with the outdoor temperature θe = 25 °C. Software: CUBE 3D 2009 [3].

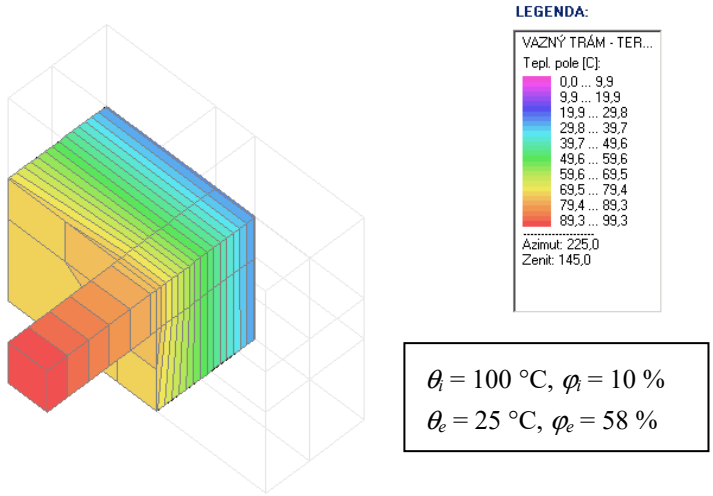

Fig. 11: Development of temperature in the place where a joining beam is located on the external attic brickwork with the outdoor temperature θe = 25 °C. Software: CUBE 3D 2009 [3].

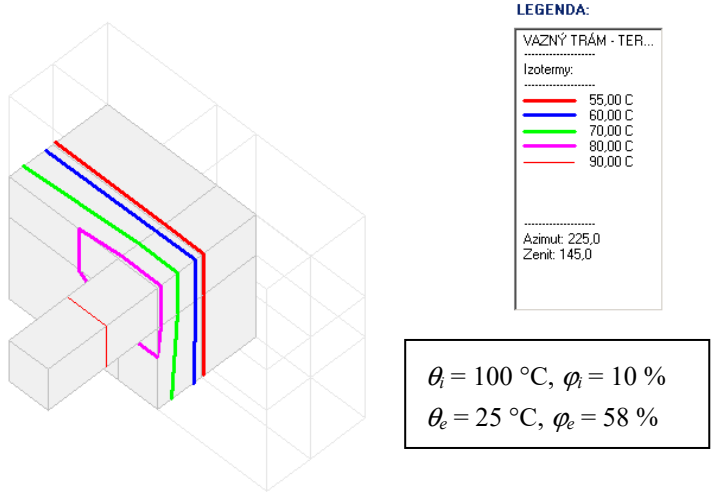

Fig. 12: Isoterms in the place where a joining beam is located on the external attic brickwork with the outdoor temperatures θe = 25 °C. The red isotherm corresponds to the required temperature: 55°. Software: CUBE 3D 2009 [3].

10.2478/v10160-011-0029-4

REFERENCES

[1] Leták 1-1WTA: *Horkovzdušná metoda likvidace živočišných škůdců dřeva v konstrukcích. WTA*, München, 2006. ISBN 978-3-8167-7752-6.

[2] SVOBODA, Z.: *AREA 2009*. Výpočtový program pro PC.

[3] SVOBODA, Z.: *CUBE 3D 2009*. Výpočtový program pro PC.

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