GROUND TEMPERATURE REGIME IN THE COWSHED ENVIRONMENT

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ABSTRACT

The investigations of ground temperature fixings in a cowshed building environment and under the building are presented in the article. Ground temperatures have been fixed on the surface and in various depths up to 3 metres. Ground surface and premise's air temperatures have been fixed inside the building. Three temperature fixing borings have been arranged inside the building and as many outside. The temperature has been fixed at 5 points and in various depths of every boring.
With the help of the ground temperature fixings on the premises of the cowshed building's animal resting area, it has been determined that in winter time the temperature from the floor's surface distributes from 14 ℃ up to 20 ℃. It is influenced by outside and inside air temperature as well as by the animal's heat transfer to the ground surface. A more active ground temperature variation of the building environment is noticeable at the depth of up to 3 metres. The fixed ground temperatures in the boring (which is moved away from the building at 5 metres) showed that the climate influences the temperature distribution most of all.

Keywords: cowshed, ground, temperature

INTRODUCTION

One of the ways to reduce the uses of heat and electricity energy in agricultural buildings and to improve microclimate is the improvement of heat isolation of the building while using effective building materials of barrier constructions.
It has been known that between outdoors and the ground (that is in structure's zone) and between the lodgment's air, intense heat interchanges go through the floors on the ground as well as through the foundations. These interchanges have a huge influence on the microclimate of the whole building (Montsvilienė, 2003; Phillips et al.1992). When the microclimate is optimal, the animal efficiency may increase to 30 %. When the microclimate is incorrect, 15-20 % of animals (especially the young ones) could die because of diseases, their weight decreases to 25 % and 15-20 % of the feed is overdraft (Sallvik, 1998).
The microclimate of the cowshed very much depends on the building's construction, the state of the building's temperature, the temperature of inside surfaces of barriers. 50 % and more of their time the animals usually rest, that is why the temperature of the floor's surface influences the heating control process of the animal's organism as well as its metabolism, heat generation and feed usage (Sallvik, 1998; Bleizgys et al., 2008).
Despite the fact that many articles concerning the questions of heat waste reduction have been published in Lithuania and are dedicated to analytical and experimental investigations of the state of temperature of the superstructure, different measures have been started to be applied, different variants of building heating have been suggested, nevertheless the influence of soils in the structure's zone is underrated (Hilty et al., 2002).
Heat interchanges through the ground are very complex. One must know the theoretical basis of physics of building heating as well as heating-moisturizing ground and material conditions, building climatology.
In foreign countries (USA, UK, Norway, Sweden, Russia etc.) different calculation methods of heat interchanges of the buildings are used while designing buildings. At present in foreign countries computer programs are used for the calculations of heat interchanges of the buildings (Ehrlemark et al., 1996).
More detailed investigations in Lithuania concerning this problem started this decade. However in scientific research works published in Lithuania as well as abroad, the detailed investigation data about the influence of ground on the state of temperature of the whole structure is lacking. Besides, the influence of outdoor factors is underrated. That is why when trying to evaluate the influence of the ground on the state of temperature of a cowshed (on which the microclimate parameters depend only partially), first of all experimental investigations must be carried out in order to determine the temperature of the ground of the animal-breeding structure. While having the factual ground temperature, it is easy to determine the heat loses of the structure through the floor on the ground.

MATERIALS AND METHODS

While selecting the place in the object for the measuring of ground temperature, the building configuration, lodgement layout, windows and

doors arrangement, animal resting and standing areas have been taken into account as well as the potential influence of outdoor factors. Temperature measurements of the ground were carried out in the cowshed in 80 places. The length of the cowshed – 66.6 m, the width – 12.5 m, the height of the lodgement – 2.4 m. Constructions of the cowshed: foundations – concrete strip, width – 40 cm, deepening – 1.1 m. Floor construction: concrete – 5 cm; gravel – 15 cm; ground – clay. There are 80 cows in two roped rows in the cowshed. The cowshed plan is shown in Figure 1.

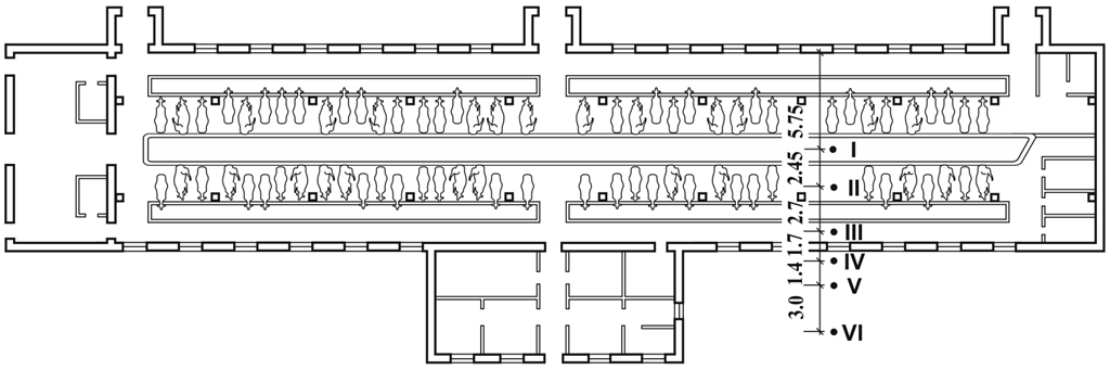

Figure 1. Plan of the cowshed: I-VI – borehole numbers

Semiconductor transistor sensors were placed to measure the temperature in every boring in a vertical direction at a distance of 0.25 m, 0.5 m, 1.0 m, 2.0 m and 3.0 m from the land's surface. Also outside of the building at a distance of 0.6 m, 2.0 and 5.0 m from the outdoor wall and in IV, V, VI borings, the above mentioned sensors were placed into duplicate depths in the land surface. All borings up to the land surface were filled up with a mix of sand and gravel.

The computer program "Surfer" was used for graphical presentation of temperature spreading in cowshed base and in its surroundings. The heat transmission from higher to lower temperature zones are displayed by pointers.

The measuring of the grounds of the cowshed was carried out from 11/2004 till 05/2005. The temperature measuring wasn't equal. They were fixed with 3-5 day intervals.

RESULTS AND DISCUSSION

The ground temperature measurements of the cowshed base and its external environment showed that the ground temperature field (under the building) is in a constant dynamic state. The heat exchange between the outside ground and the one under the building as well as on the floor is influenced by the external temperature regime.

A very intense heat exchange takes place during the stable period, i.e. during the winter months. For example, in November, when the outdoor temperature drops below 0 C°, the base ground temperature under the floor near the foundation (0,25 m) drops to 6-8 °C. At that time, the surface temperature of the foundation is 5.0 °C lower than the surface of the area in the middle of the floor (Fig. 3., 4 curve). At lower outdoor temperatures the cowshed's interior ground and floor chilling occurs partly due to the cold wall of the premises, because the wall thermal resistance is ≈1 m^2K/W. When the outdoor temperature dropped more than -10 °C, the temperature of the floor near the foundation (III ground temperature measurement point) was 5 °C lower than in the middle floor area (I ground temperature measurement point) (Fig. 3., 1 and 2 curves). In May and June, when base ground thaws, the temperature fluctuations in floor surface are relatively small – from 1 to 3 °C (Fig. 3., 6 and 7 curves). A computer program was used for the graphical presentation of the temperature distribution of the ground in the cowshed inside base and its external environment. Using the data of

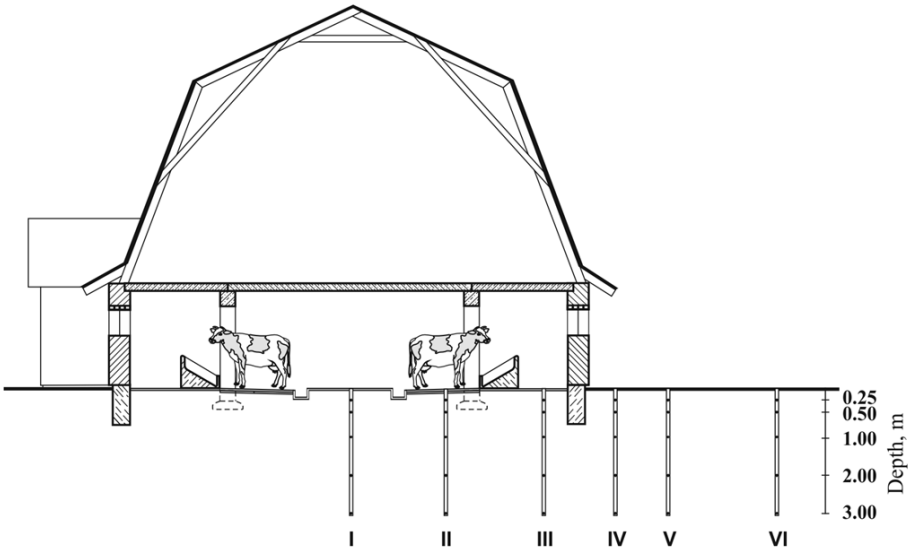

Figure 2. Arrangement of the measuring boreholes of the ground temperature of the cowshed internal base and external environment as well as temperature sensing depths in them

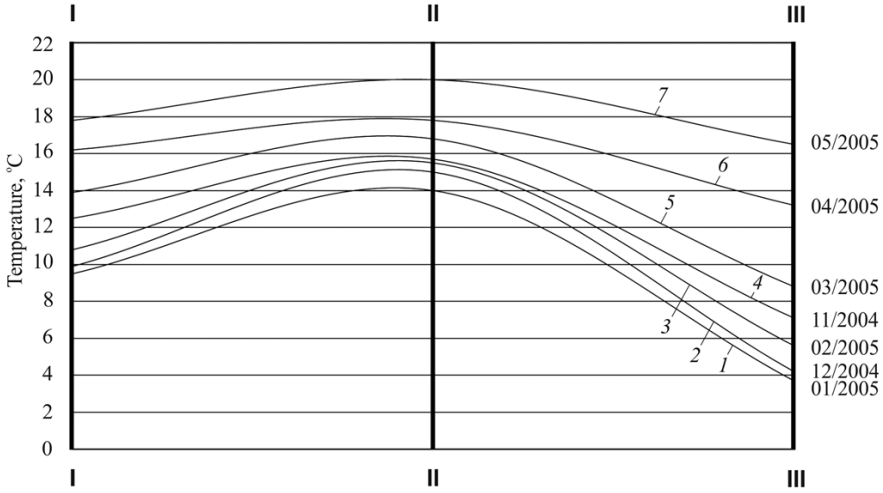

Figure 3. The temperature of the floor surface of the cowshed building in various periods of the year: I-I – in the middle of the cow housing room; II-II – in the cow standing area; III-III – inside the building near the outside walls

the cowshed internal base ground temperature measurements, the cowshed building base ground uniform temperature distribution lines - isotherms were obtained (Fig. 4). A set of isothermal surface consists of these lines. The temperature difference and the distance between the two isotherms ratio gives the temperature gradient, which describes the propagation of heat. Heat propagation directions from a higher temperature area to a lower temperature range, as well as directions of the grounds in the cowshed inside base and its external environment are presented by arrows (Fig. 4).

Following the building's external environment, the ground temperature measurement analysis of the results showed that the ground frost depth of the building (farthest from the remote wells) (Figure 4., VI ground temperature measurement point) was only 0.6 m in winter time. Such shallow ground frost could affect the cowshed building internal base ground temperatures. Therefore, it can be said that to some extent, the cowshed building internal base temperature depends on the outdoor air temperature. However, the cowshed internal base temperature experimental measurements show that the radiated heat from the animals in their living quarters has a significant influence on the internal base temperature field. This is apparent in Figure 3., where the highest temperature is on the floor surface of the living quarters (II ground temperature measuring point). The radiated heat from the animal at the site of its living quarters is transmitted not only to the surrounding surface of the living quarters and the floor, but to the ground floor in the deeper layers as well. Particularly intense

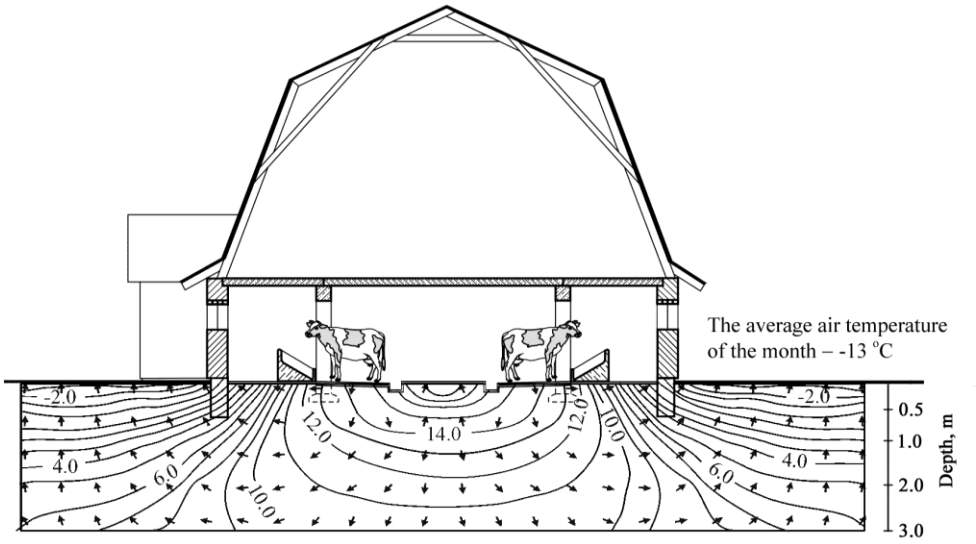

Figure 4. The average ground temperature of the cowshed base and its environment, when the coldest month outside air temperature was during the research period (01/2005)

heat exchange between animal living quarters and the building external environment air manifests in cold season through the base ground and building foundations. However, not all the heat is transferred to this direction. Some heat radiated from the animals through the floor comes back into the room next to the floor area into the ground living quarters due to the air temperature difference in the ground floor and ground surface. Such thermal movement of the subfloor ground is possible when the outside air temperature is much lower than -10°C. When the weather gets warmer, the temperature distribution of the building internal base ground and its external environment becomes more equal (according to depth) (Fig. 4).

CONCLUSIONS

Intense heat exchange between the outside air and ground-based cowshed through the foundation manifests itself during the coldest time of the year. When the outdoor temperature drops below 0 C°, the base ground temperature under the floor near the foundation drops to 6-8 °C. When the outdoor temperature has dropped more than -10 °C, the temperature of the floor near the foundation is 5 °C lower than in the middle floor area (9-10 °C).

The experimental temperature measurement data show that heat radiated by animals, that is absorbed not only in the air, but also in the base ground through living quarters floor has a significant influence on the internal base ground temperature field. Some heat radiated from the animals through the floor comes back into the room next floor area into the ground living quarters due to the air temperature difference on the ground floor and ground surface.

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