USE OF VENTILATION AND INSULATION IN SINGLE FAMILY HOUSES FOR THERMAL COMFORT, ENERGY CONSERVATION AND PROTECTION AGAINST MOISTURE, DUST AND RADON. THE OPTIMA CONCEPT.

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1. Introduction

Ventilation can be used in many ways in single family houses for comfort, energy conservation and protection against pollutions. Special effects can be attained by integration of the ventilation system to the insulation and to the structure.

2. Purpose of the work

The intention was to study the function of the OPTIMA ceiling and floor in a single family house. The system works as follows, see figure 1.

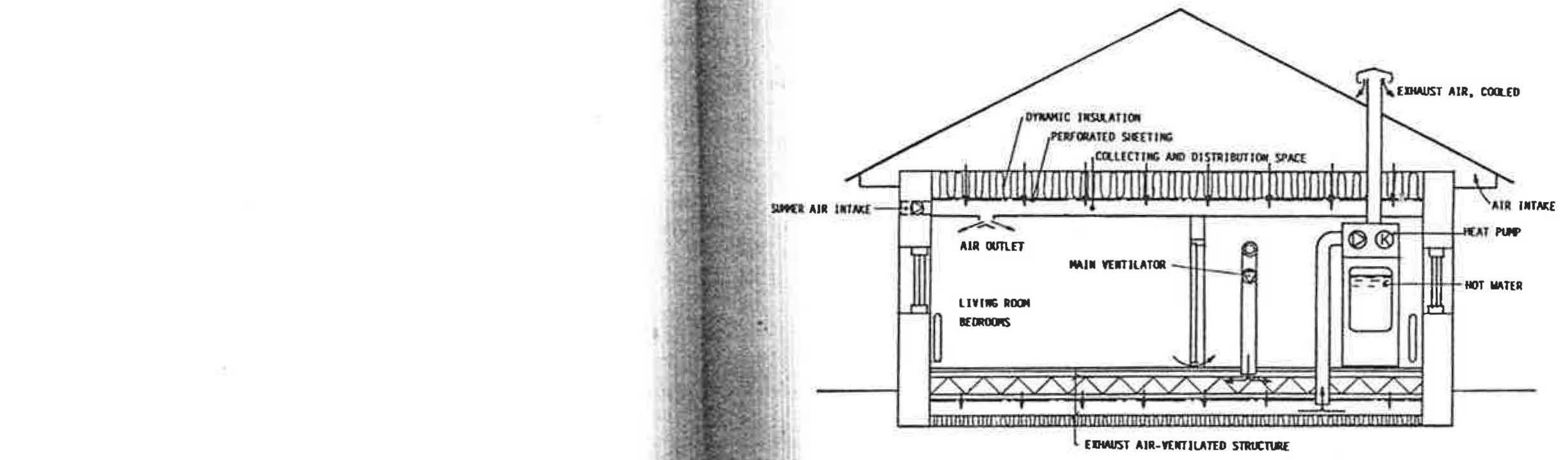

Fig. 1. The Optima concept

Fresh air is taken into the house via the roof structure and infiltrates through the ceiling insulation and a control film to a collecting space in the bottom of the ceiling. From there it is let out to the living room and bedrooms by special air supply units.

After using the air in these rooms it is passed on to the bathroom, lavatory etc through slots under the doors. From here it is drawn to the main ventilator and let out to the floor structure which allows air flow in all directions. The warm air is distributed in the upper part of the structure under the entire house. Then it leaks trough a polymer fabric to the lower part from where it is drawn by an exhaust fan.
Before leaving the house, the remaining heat in the exhaust air can berecovered by means of a heat pump. The exhaust air can be preheated before blowing it down into the floor structure. The heat can possibly be taken from the heat pump.

3. Method of approach

The system was set up in an 18 m^2 house with two rooms of 9 m^2 each. The house was built with a wooden structure. The mineral wool insulation had a thickness of 120 mm in the roof and walls and 70 mm on the ground. Radiactive slate was laid on the bottom insulation in the floor structure to generate radon.

The house was heated by electrical radiators, one in each room, placed 200 mm above the floor. The house contained 3 fans that blew the air.

1. From the roof to the outer room.

2. From the inner room to the floor structure.

3. From the floor structure out of the house.

The air flow was 6,3 l/s. The air was not preheated before blowing it down to the floor structure. A humifier was put into the inner room, which corresponds to the bathroom part of the house,to simulate the moisture emission of the household.

Sixty computer-controlled indicators were installed to measure temperatures, relative humidity and moisture content once per hour for a year.

The radon concentration in the living area was indicated by a method recommended by the University of Lund.

4. Significant results

Figure 2 shows the typical behavior of the dynamic insulation in the ceiling. It is clear that the temperature in the middle of the insulation is lower than in a non-dynamic insulation. This means that the incoming air takes up the heat that leaks through the fibres. In this way the insulation works as a heat exchanger as described by the inventor Torgny Thorén (3).

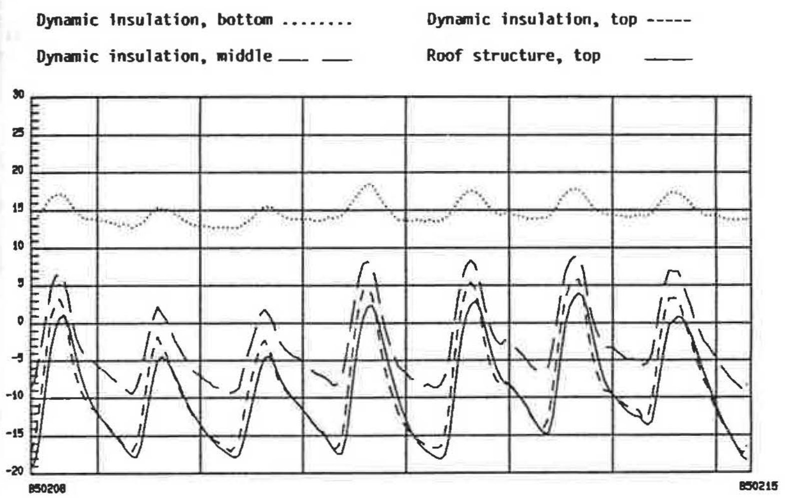

Fig. 2. Temperatures °C in the roof during a winter week

Figure 3 shows an example of the temperature picture in the air and in the ground a cold winter day.

We can see that the floor recovers heat from the exhaust air corresponding to the temperature differens of 23,3 - 13,0 °C.

The temperature of the floor is not very high. This depends on

1. The radiators were placed too much above the floor.
2. The house is extremely small so that the walls have great influence on the heat flow from the floor structure.
3. The house was new why the heat buffer in the ground was not completely developed.

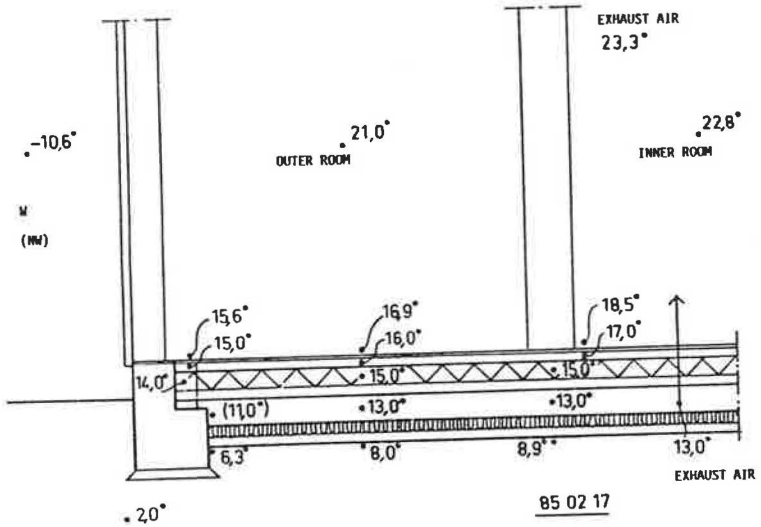

Fig. 3. Temperatures °C in and around the floor structure a winter day, mean values

The highest moisture content mesured in the wooden beams of the floor structure was 18 %. This happened in the autumn. In the winter the moisture content was much lower.

In spite of the radioactive layer on the ground insulation, the radon concentration in the living area was as low as 14 Bequerel/m^3 while it was 370 in the exhaust air from the floor structure.

5. Conclusions and practical aspects

The Optima concept can give one family houses a number of good qualities such as

1. Controlled ventilation of the roof structure, that can be important especially at low roof slopes.
2. Recovery of most of the heat losses through the ceiling insulation.
3. Preheated and filtered fresh air, freed from dust, pollen etc, let into the rooms without draught and noise.
4. Floor with good thermal comfort when the radiators are placed not more than 100 mm above the floor.
5. Protection against moisture in the floor structure. The ventilation can be controlled so that the moisture content in the exhaust air not exceeds a given value.
6. Protection against radon infiltration from the ground.
7. Low-built roof structure that allows easy communication and accomodation for disabled persons.
8. Easy to remove leaking water from the floor structure without damages.

6. References

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(4) Södergren D, Fagerstedt A, Dynamisk isolering R 34:1984, Statens råd för byggnadsforskning, Stockholm 1984.