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NATURAL PROVISION OF DWELLINGS WITH SUPPLY AIR BY THE "DORTMUND VENTILATION" SYSTEM

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SUMMARY

The ventilation system described here combines a central air shaft in the hall area with a mechanical waste air extraction system in the bathroom and in the kitchen. If there is a large amount of moisture in the dwelling, the volumetric flow of the waste air fans is increased, the increase being controlled by means of hygrostats.

This ventilation system ensures adequate ventilation of the dwelling. In dwellings without a supply air shaft, this hardly applies any more with the installation of windows with very low joint permeability.

1. INTRODUCTION

The Heat Conservation Ordinance in the Federal Republic of Germany /1/ requires that, when new windows are installed, there be a minimum joint thickness. Thanks to competition between the manufacturers, this has been exceeded by a wide margin. Thus there are today quasi joint-tight windows. These new windows considerably restrict the natural flow of supply air for conventional shaft ventilation systems. Wegner /2/ investigated a number of dwellings with highly noise-insulating ventilation windows which were partly with several seals and measured a mean air exchange of n = 0.35 per hour. Ehrhorn and Gertis, on the other hand, demand in /3/ a minimum air exchange of n = 0.8 per hour for the transitional seasons (autumn and spring) to remove the moisture produced, and for the winter season n = 0.5 per hour. The consequence of the inadequate air exchange is an increase in the steam and pollutant concentration in the room air. In an investigation of the damage caused by mould in modernised dwellings /4/, Ehrhorn found that just under one third of all cases of damage can be attributed to an excessively high room humidity.

To restore a natural supply air route, the "Dortmund ventilation" system was designed as a centralised supply air system in the centre of the dwelling (e.g. in the hall). Furthermore the exhaust air shafts of the "Berlin ventilation" system were fitted with hygrostatically controlled fans to ensure that the moisture produced was also reliably removed by short-term ventilation even with peak loads (cooking, showering etc.).

2. TEST DWELLING

Figure 1 shows the layout of the test dwelling and the adjacent corner dwelling. In the corner dwelling the only interior room is the WC. The ventilation for this room is the widely used "Berlin ventilation" system. The exhaust air is removed via a shaft with natural ventilation. Since the kitchen, which is externally situated in this dwelling, and the bathroom each have a window for ventilation, there is no exhaust air shaft here. The State Building Regulations do not lay down additional ventilation installations for kitchens and bathrooms with external wall. This means that the kitchen and bathroom have to be ventilated, as required, by window ventilation. Only for the internal WC is there an additional supply air flow through the leaks in the building shell.

In the test dwelling, there are in the bathroom and the kitchen the exhaust air shafts of the "Berlin ventilation" system, fitted in addition with an exhaust air fan. Furthermore, in the hall, directly next to the front door, there is the supply air shaft of the "Dortmund ventilation" system for the natural back-up flow of outside air. To conduct tests, there is the possibility of sealing the opening between the supply air shaft and the hall and to remove the fans in the exhaust air shafts. With this arrangement, the "Berlin ventilation" system is achieved. Figure 2 shows a cross section through the whole building. It reveals the supply air shafts of the "Dortmund ventilation" system and the exhaust air shafts of the "Berlin ventilation" system. This makes clear that the supply air can be fed into the building as required on street level or through the roof. For the purpose of comparison there are in the house three other dwellings with the same layout, and an attic dwelling with a similar layout. These dwellings are also equipped with the natural supply air shaft of the "Dortmund ventilation" system and the exhaust air shafts of the "Berlin ventilation" system.

3. CONDUCT OF INVESTIGATIONS

In all five dwellings with the "Dortmund ventilation" supply air shaft, the temperatures and relative humidities of the living and bedrooms were measured constantly and stored as hourly mean values. A survey of the inhabitants of these dwellings revealed that the user behaviour of the inhabitants on the ground floor and the first floor is comparable.

On 12.03.1989, the supply air shaft in the dwelling on the ground floor was sealed, so that in this dwelling only the "Berlin ventilation" exhaust air system is installed. Figures 3 and 4 show the absolute humidities determined for the months of February, March and April 1989 as a difference to the absolute humidity of the outside air. It has proven useful to present the absolute room humidity as a difference to the outside humidity, the purpose being on the one hand to highlight the window ventilation behaviour of the inhabitants and, on the other, to eliminate the influence of the outside climate when considering various periods (as in Figure 5). In Figure 3 it is possible to see from the very low absolute humidity differentials that the bedrooms on the ground floor and the first floor are regularly ventilated through the open window. This is confirmed by the survey conducted among the inhabitants. The inhabitants are elderly people who have been used from childhood to keeping their bedroom doors closed and to opening the window regularly. With the regular ventilation of the bedroom through the window, it is not possible to make any distinction between the two ventilation systems. With regard to the living rooms, however, such a difference is present, as can be seen in Figure 4. This figure makes clear that the room air of the living room on the ground floor is clearly more humid than that on the first floor. This is not the case for the period before 12.03.1989, where "Dortmund ventilation" was installed in both dwellings.

This result is confirmed by a test in the test dwelling on the third floor. Figure 5 shows the absolute room humidities as a difference to the outside humidity in two successive January weeks. In the first week the supply air shaft of the "Dortmund ventilation" system was open, and in the second week it was closed. In this examination, it is necessary to use absolute humidity differentials in order to eliminate the different outside climate in the two weeks. If one considers the whole period, it can be seen that the rooms with an installed supply air shaft are drier than those with a closed supply air shaft. It is not appropriate to consider individual instantaneous values, because even in the same dwelling the user behaviour is different in two successive weeks.

If we consider the volumetric flows with the installed natural supply air shaft of the "Dortmund ventilation" system and the natural exhaust air shaft of the "Berlin ventilation" system, it can be seen that in Winter the dwelling is more than adequately ventilated. In January and February, a volumetric flow of 160 m^3/h is measured at the two exhaust air shafts. In Summer there is no evidence of major air movements because of the lack of, or only very slight difference in density between the room air and outside air. Since the system described is designed as a basic ventilation, i.e. there is no intention to do without window ventilation all together, the volumetric flows in winter are too high, which is not desirable with regard to energy management. This and the only very low volumetric flows in summer necessitated the regulation of the volumetric flows by installing exhaust air fans. These fans each move a volumetric flow of 30 m^3/h at their basic stage. If there is a high humidification, the fans are switched to a higher stage, controlled via a hygrostat. Here they each move a volumetric flow of 80 m^3/h.

In humidity tests, an extremely high humidity was simulated by evaporating water. These tests showed that the humidity level was buffered by the adsorption of the steam in the wall and various items of equipment. Since the hygrostats in the bathroom and kitchen cannot register a high humidity level in the living room and bedroom, and since the humidity level in the room is kept high by desorption of the steam from the walls and items of equipment, it is not possible to dispense with sudden window ventilation.

RESULTS

If there is regular window ventilation, it is guaranteed that dwellings with the "Berlin ventilation" exhaust air system are adequately ventilated. But investigations in modernised rented housing construction, such as /4/ and /5/, show that in many cases no, or at least only inadequate ventilation through the window is practised. An extensive survey conducted in Belgian social housing /6/, covering 1115 one-family houses and 1219 flats, reveals that 30 % of all rooms are never ventilated. A supply air system such as the "Dortmund ventilation" system is absolutely necessary.

The investigations showed that dwellings with the "Dortmund ventilation" natural supply air system and the "Berlin ventilation" exhaust air system are drier than those with only the "Berlin ventilation" exhaust air system. Since the function of a natural exhaust air system is limited in summer, and volumetric flows arise in winter which exceed the necessary level, a hygrostatically controlled mechanical exhaust air system is more beneficial.

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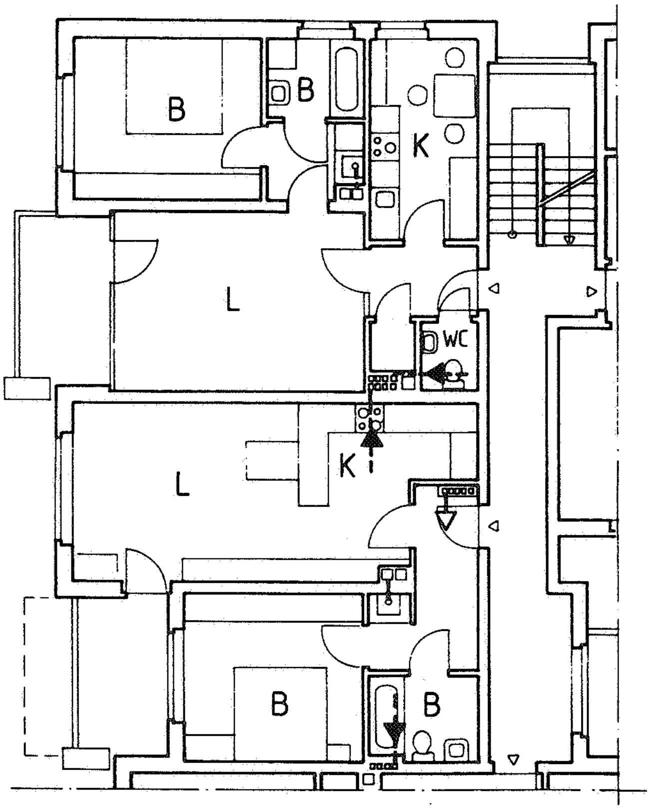

Figure 1: Layout of the test dwelling and neighbouring corner dwelling with arrangement of shafts

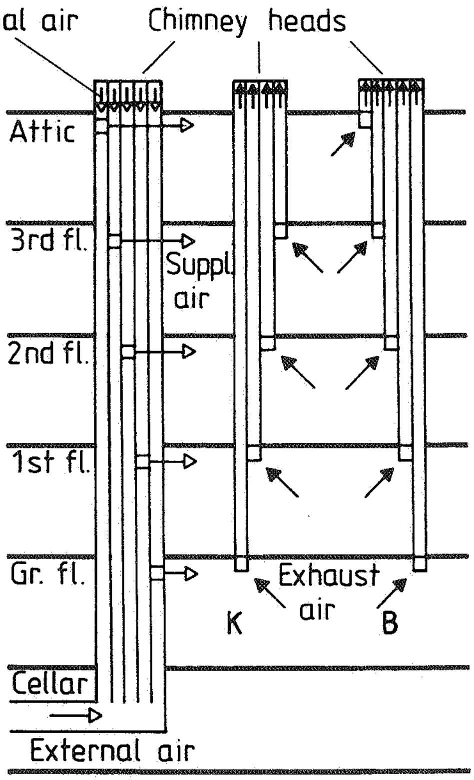

Figure 2: Cross section through the building

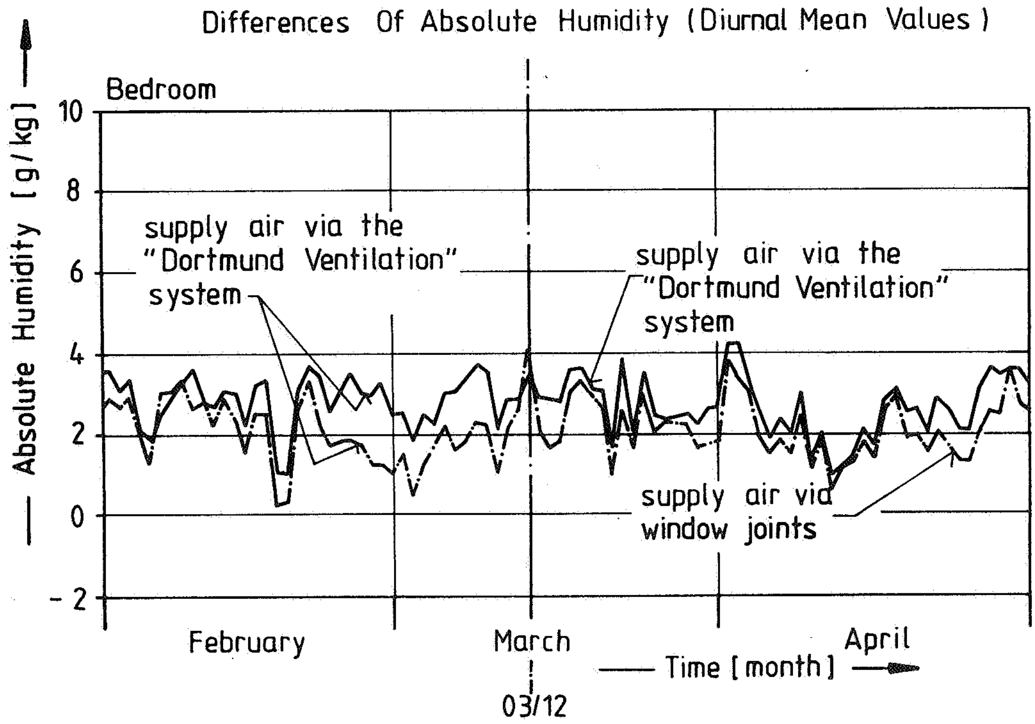

Figure 3: Test results for the bedroom on the ground floor and on the first floor

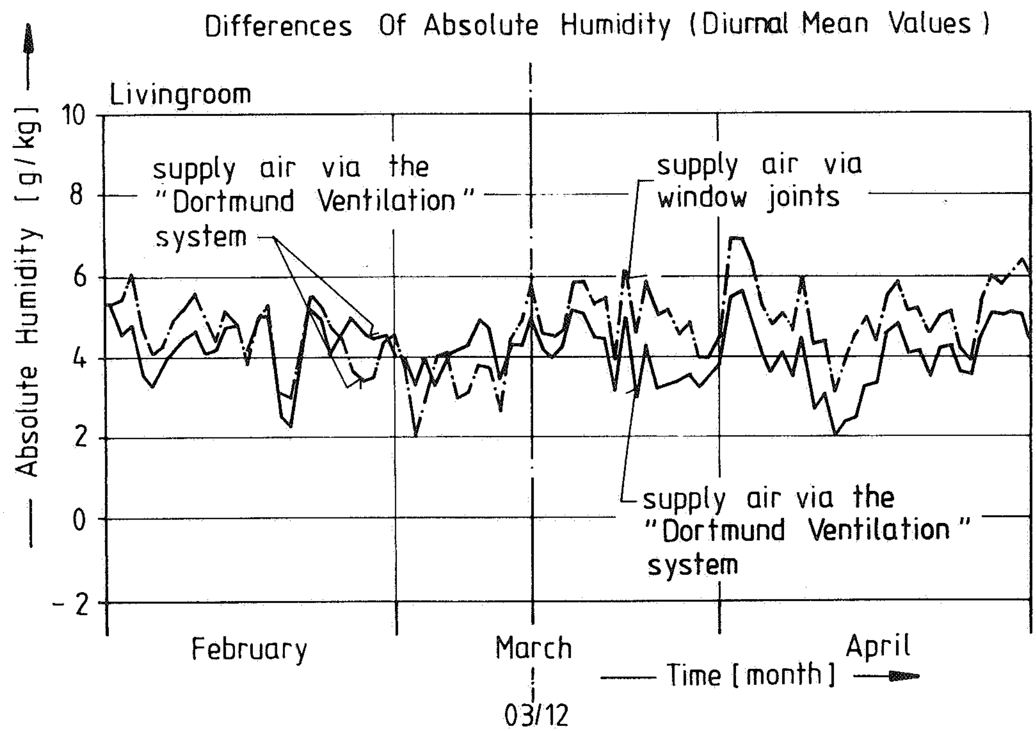

Figure 4: Test results for the living room on the ground floor and on the first floor

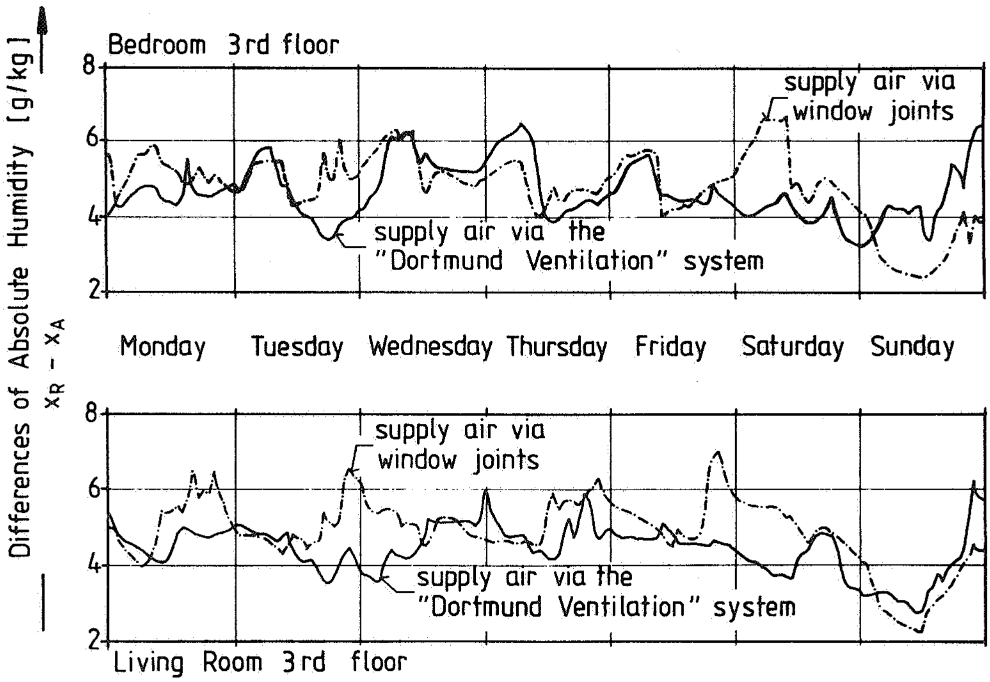

Figure 5: Test results for the bedroom and living room in the test dwelling