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THE LOFT AS AN AIR ESCAPE ROUTE

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One important consequence of measuring ventilation rates in houses by a constant concentration method is that it is possible to determine the proportion of total volume of air leaving the house which does so through the loft space. To do this it is necessary to employ a second tracer gas with which to measure the loft ventilation rate.

Experimental Details

A schematic view of a typical experimental installation is shown in Fig 1. We use CO_2 to measure the loft ventilation rates. The gas is injected at constant flow rate, into the stream of the 2 mixing fans which ensures thorough and rapid dispersal. The concentration of CO_2 is sampled every minute as is the concentration of N_2O, the tracer gas used in the house itself. The N_2O and CO_2 samples are the average of 5 sampling points. At equilibrium, the average CO_2 concentration, the loft volume and the CO_2 flow rate enables us to determine the volume of air passing through the loft, or the loft ventilation rate.

$$\text{The volume of air flowing through the loft, } m^3/h = \frac{\text{flow rate of } CO_2 \; m^3/h}{\text{mean concentration of } CO_2 \, v/v}$$

$$\text{The loft ventilation rate} = \frac{\text{the volume of air flowing through the loft, } m^3/h}{\text{loft volume, } m^3}$$

Having thus determined the total volume of air flowing through theloft we can use the mean concentration of N_2O in the loft to estimate the volume of house air which finds its way to the loft. Finds its way is an appropriate term, since house air can gain access to the loft through several routes, directly, through cracks and gaps in the ceiling on the upper floor and indirectly through the wall cavity from all rooms.

The volume of room air entering the loft from the house is,

$$\frac{\text{the mean } N_2O \text{ concentration in the loft air}}{\text{target constant concentration in the house air}} \times \text{(the volume of air flowing through the loft)}$$

From this figure and the total volume of air leaving the house, which we derive from summing the individual room rates, we can work out the proportion leaving through the loft.

This experimental method can be extended to measure air movement within the house. For instance, the movement of air from ground floor to first floor or the movement of air from the basement of the house, or from any particular room to the rest of the house, can all be determined from two tracer gas experiments.

Examples

Two examples are cited where we have used this technique to measure loft ventilation rates and the proportions of air leaving the house through the loft.

The first, was in our 4 bedroom detached house. This house is old and leaky with multiple adventitious openings and has a tile hung roof with mineral felt beneath. The axis of the roof runs N-S and has solid gable ends. Figure 2 shows the loft ventilation rate as a function of wind speed. It is interesting, or perhaps obvious, that E or W winds induce the highest air change rates for a given wind speed. N and S winds induce much lower air change rates, presumably because of the orientation of the roof tiles with respect to the wind. Our experiments showed that, generally speaking, the higher the wind speed, the less the proportion of air leaving the house through the loft space. This is reasonable in that with zero wind speed we might expect nearly all of the house air to leave through the loft under the influence of the stack pressure. The range of values we measured was from 80% with a 1m/s wind to 40% with 5m/s wind. Both these values were for winds from the West. For N or S winds the proportion leaving via the loft was 50% to 70% for winds in the range 1 to 5m/s. For all the tests there was a termperature differential of 10 - 15°C. Our results show that stack effect has a considerable role to play in the ventilation of even two storey houses.

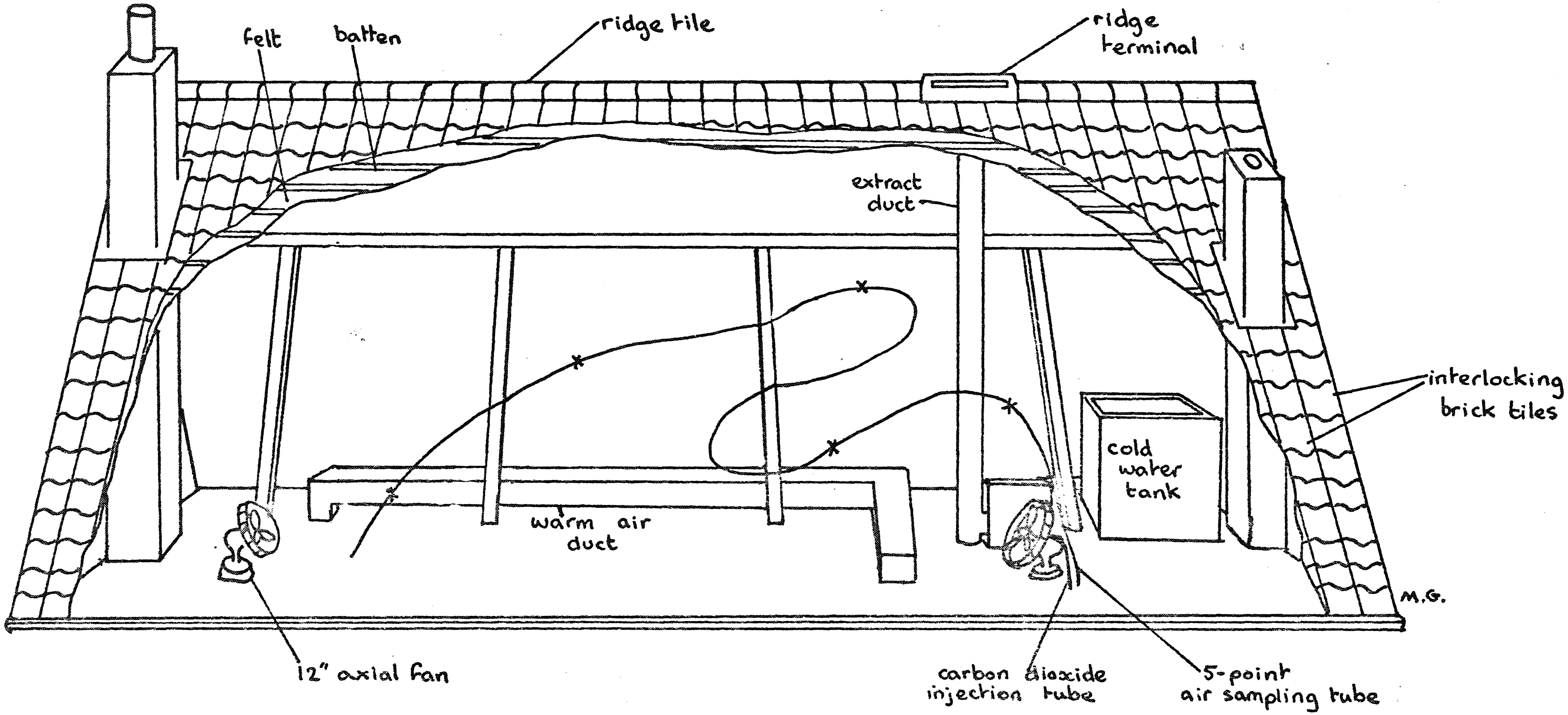
The second example concerns a much newer test house, a lower energy house. This house is a mid-terrace house and has windows and doors in the N and S faces. The roof axis runs E to W and the roof construction is of interlocking concrete tiles over felt and battens.

The loft ventilation rate in this house is much lower than that for the other house. This may be due to the sheltered nature of a mid-terrace house or to the quality or type of roof construction. There is a much less marked difference between the effects of winds from different directions. The proportion of air leaving the house through the loft space was much greater for this newer house. Indeed, the value was never less than 60% and was often greater than 95%. Only when 2 windows were opened on the upper floor did the proportion fall below 60%, in this case it was around 35%. These differences we presumed due to the generally tighter nature of the structure.

Discussion

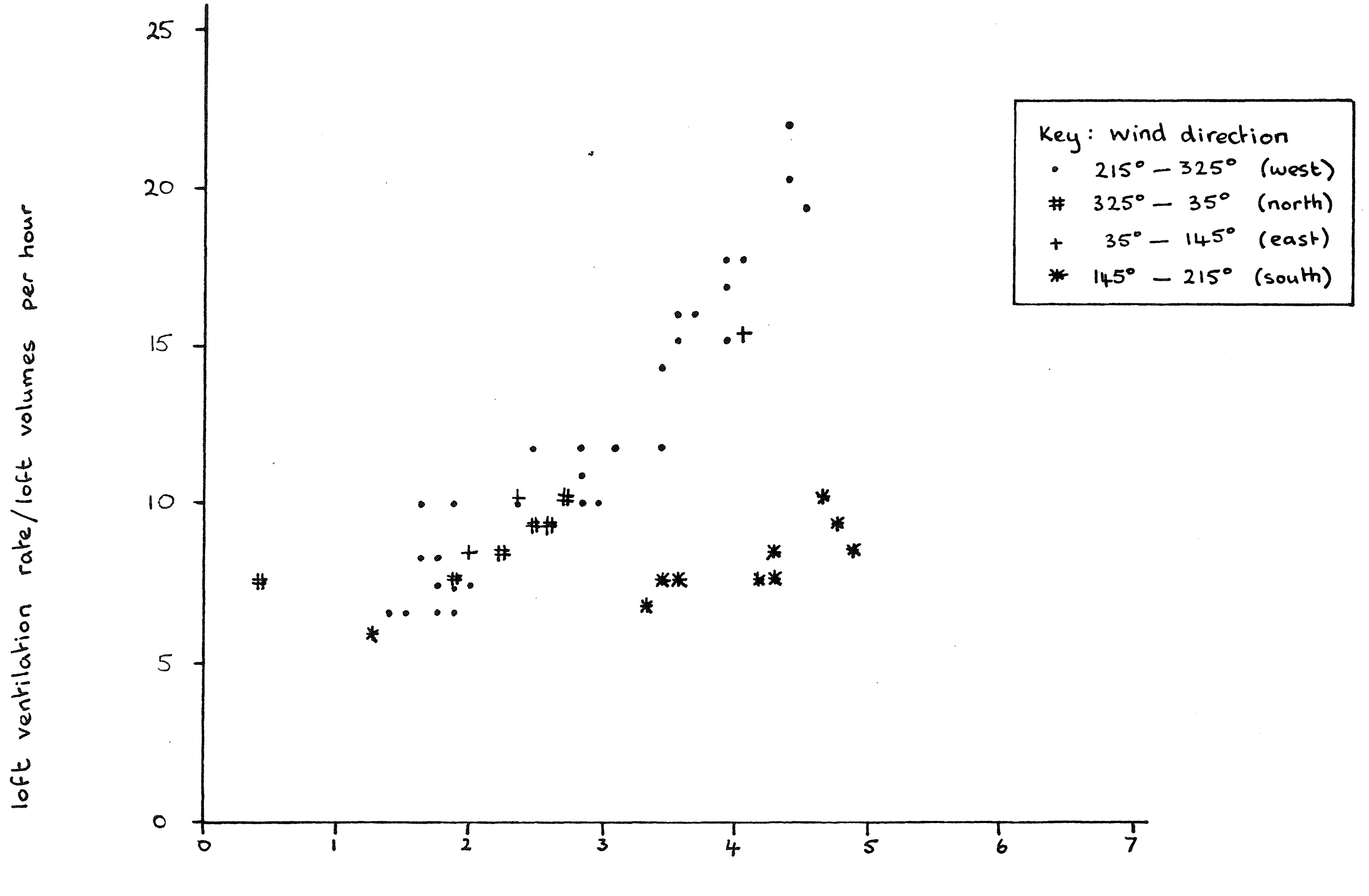
It is clear from these results that air escape to the loft is an important pathway for air leaving houses. This suggests that one campaign that should be waged, in the battle to conserve energy, is to investigate ways to restrict air flow to the loft space. In our experience gaps around soil pipes and electrical fittings, hairline cracks, loft hatches and hollow cavity walls are among the common pathways. Attention to the sealing of these routes could make a significant contribution to energy conservation by restricting excessive air change rates in houses.

FIGURE 1 EXPERIMENT TO MEASURE LOFT VENTILATION



View of the loft space through the west side of the roof.

FIGURE 2. <u>LOFT VENTILATION SEGAS HOUSE</u>



Graph of loft ventilation rate against wind speed.

FIGURE 3 LOFT VENTILATION FOR LOW ENERGY HOUSE