BRF-kredit Headquarters, Lyngby

Building Description

This building is located in Lyngby about 10 kilometres north of Copenhagen City. It is the headquarters of BRF-kredit, a financing institute for property mortgages. The building, constructed in 1986, is a four-storey office complex, consisting of a main building and three interlinked office blocks. Figure 1 illustrates the main building and the first of the three office blocks. The main building is exposed to a moderately busy road whereas the three remaining office blocks face quieter surroundings.

A typical floor plan is illustrated in Figure 2 while Figure 3 shows a sectional view of one of the office blocks. The main building has a central atrium which extends down to the ground floor, while the office blocks have lengthwise, glass covered arcades which connect the first, second and third floors only.

The main activity in this building is administration. There are both open plan offices holding up to 10-15 people and single person cellular offices. In total, the building houses about 600 occupants. The floor area is approximately 20,000 m^2; of which approximately 50 % is office space and meeting rooms, 30 % is circulation area and the remainder is used for services (cloakrooms, plant room etc.).

This building is of high mass construction, consisting of reinforced concrete columns and girders supporting prefabricated facades which are finished with a brick exterior face.The windows have aluminium frames and are triple-glazed, while the arcade windows are double glazed. There is 4 m^2 of skylight glazing for each metre length of arcade, resulting in about 85% glazing. These skylights have an exterior fabric shading which is automatically controlled according to arcade orientaion via individual sensors. There are also manually operated exterior venetian blinds to shade each office window.

Figure 1: View Showing Main Building in Foreground and Office Block 2 on Right

Mechanical ventilation is provided only in the meeting rooms, toilets, canteen and central computer room. In addition, the central computer room is mechanically cooled (air-conditioned). Space heating is supplied by a conventional radiator system with thermostats on each radiator. A joint heating plant, fuelled by natural gas, supplies space heating and hot water.

From the outside, the BRF-kredit Headquarters appears very compact and closed, but from the inside it is very open and friendly, mainly due to the large open circulation areas with skylights. The building has a distinctive character, but is, nevertheless, of a reasonably traditional design. The building could therefore serve as an example for a fairly sophisticated yet uncomplicated future office building, based on natural ventilation.

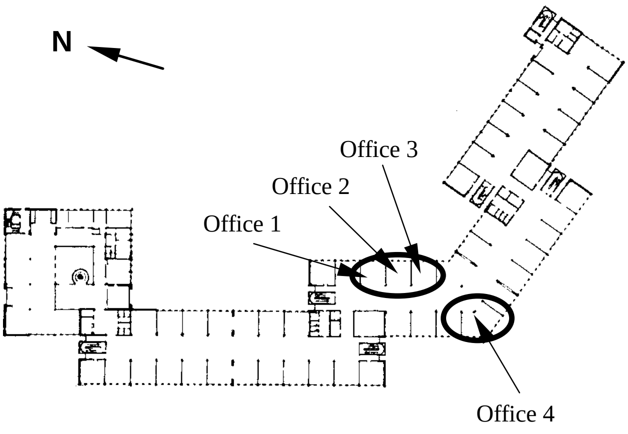

Figure 2: Floor Plan Showing Offices Monitored

Ventilation Philosophy and Aims

The aim of the ventilation system is to provide temperature control in summer and indoor air quality control in winter. In the office blocks, ventilation is based on occupants' use of multi-position windows in combination with the automatically controlled opening of windows in the skylights. The system allows night cooling to take place. In addition, automatically controlled exterior solar shading contributes to reducing the risk of overheating due to excess solar radiation.

Ventilation Technology

The open architecture of the arcades makes it feasible to naturally ventilate the office blocks. The arcades can be used as “stacks” or chimneys, which allow stale air to be removed through open skylights at the top; outdoor air can enter the building through office windows. In each office block, the opening of the skylight windows is controlled by means of a number of temperature sensors positioned in the upper part of the arcade. For security reasons windows on the ground and first floors must not be left open during the night. In addition, office doors on all floors must be closed and locked at night. Night cooling potential is therefore restricted to making use of window opening on the upper (second and third) floors only (see Figure 3).

Both the skylight fabric shading and the venetian blinds are controlled automatically through the use of light sensors. The venetian blinds can also be operated manually on an individual basis. The manual over-ride is not permanent and reverts to the automatic setting after a time. Figure 4 shows a section of the interior of a typical open plan office.

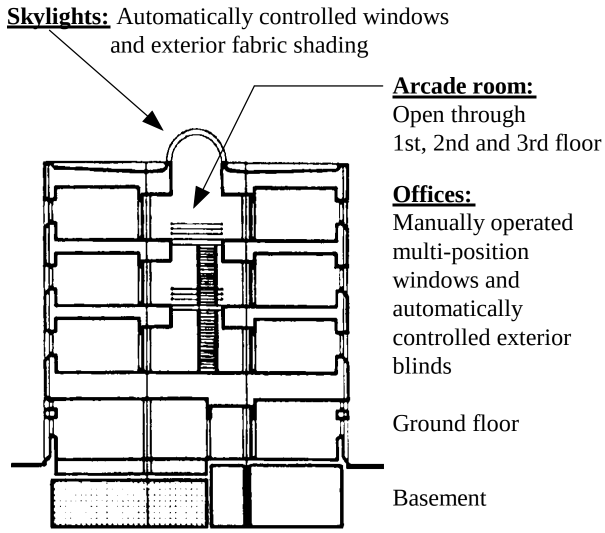

Figure 3: Section of an Office Block

As well as the on and off operation (up/ down) of the exterior blinds, the angle of the slats can be adjusted according to the altitude of the sun. There are two positions, one for summer and one for winter. For security reasons the blinds must be fully closed during the night so they are automatically closed at 20.00 hours. Even when the blinds are closed, they allow the supply of outdoor air through open windows on the second and third floors. Artificial lighting is also controlled automatically.

Figure 4: Interior of an Office Showing Exterior Blinds and Multi-Position Windows

Monitoring Programme

Four offices on the third floor of office block 3 were chosen for the investigation (see Figure 2). Office 1 is a relatively large cellular office (25 m^2), offices 2 and 3 are smaller cellular offices of equal size (12 m^2 each) and office 4 is a large open plan office (50 m^2) holding 8 people. Offices 1, 2 and 3 face east, whereas office 4 is a corner office facing south-west.

Apart from the basement, which comprises various storerooms and repair shops for office furniture and equipment, the activity in the building is predominantly administrative. The occupants use personal computers and, in the offices investigated, there is one for each occupant.

Measurements made during the monitoring campaign included the continuous recording of outdoor air temperature, and indoor (dry bulb) temperature, fresh air ventilation rate (by constant concentration tracer gas analysis) and carbon dioxide concentration in each office.

The offices were monitored for two periods, one in the summer (July to September 1997 inclusive) and one in the winter (November and December 1997). In addition to the technical measurements, the building occupants were invited to fill in questionnaires, one for each of the monitoring periods. For both periods, essentially the same staff were canvassed and were drawn from the ground floor to the third floor of office block 3. Approximately one hundred staff members responded to the questionnaire.

Summer Monitoring Results

Although monitoring took place over three months in the summer, only excerpts of the results are presented here.

Thermal comfort and air quality: During August, there was a particularly warm period, lasting about three weeks, when the outdoor temperature peaked at between 23 and 27°C and was rarely below 19°C. The indoor temperature (average of simultaneous recordings in four offices) was constantly above 25°C, and on extreme days it peaked close to 30°C.

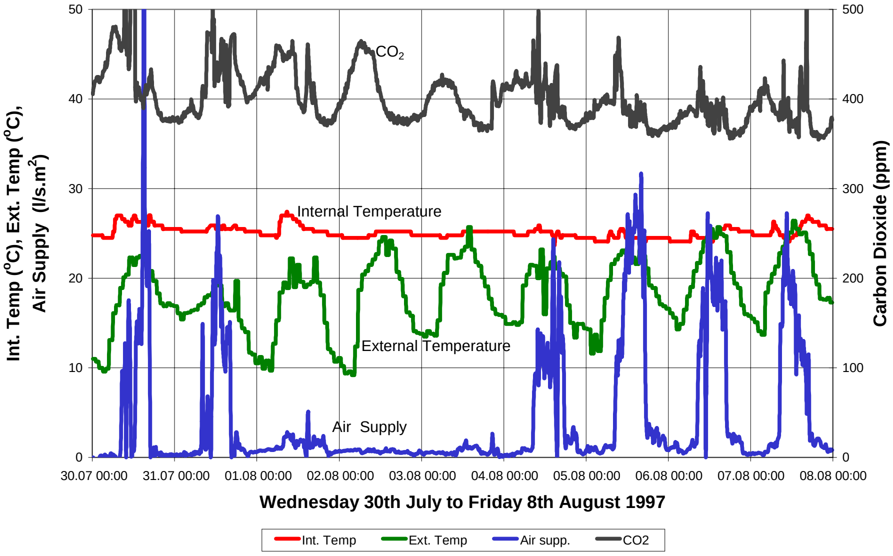

Figure 5: Summer Monitoring Results in Office 2

Figure 5 shows results for approximately one week of monitoring in office 2. The weather for this week was more typical for summer than the exceptionally hot weather described above. The results of the monitoring of the outdoor air supply in the office shows substantial air supply during the day. Despite being able to leave the office window open at night, the night-time ventilation rate is much reduced. This is because the windows are only left slightly open and the interior doors are locked shut. As there are no grilles in the internal doors, effective use of cross ventilation during the night was restricted.

The carbon dioxide concentration of office 2 was found to be well below critical level (1000ppm), thus indicating that the ventilation rate was sufficient to meet occupant and basic air quality needs. At night and at weekends, the carbon dioxide concentration reduced to the ambient outdoor level of approximately 400 ppm.

For part of the monitoring period, the mean air velocity was measured. Values greater than 0.15 m/s (draught threshold) were recorded during the day but they went down to around 0.05m/s during the night and at weekends.

Winter Monitoring Results

Figure 6 shows approximately one week of the winter monitoring results.

Thermal comfort and air quality The measurement results show distinctly different conditions in the offices during office hours as opposed to nights and weekends. In occupied offices the indoor temperature reached about 22°C, the CO_2 concentration was 1000 – 1200 ppm and, in office 2, given here as an example, the outdoor air supply peaked at approximately 5 l/s.m², (i.e. about 7 air changes per hour). The day time carbon dioxide level indicated that the ventilation rate was running at close to the minimum needed to meet the air quality requirements of the occupants. During weekends the indoor temperature dropped to 17 – 18°C, the CO_2 concentration dropped to near the background level (400 ppm), and the outdoor air supply was close to zero.

Evaluation of Occupant Reactions

Figures 7 and 8 summarise the occupants' ratings of various environmental

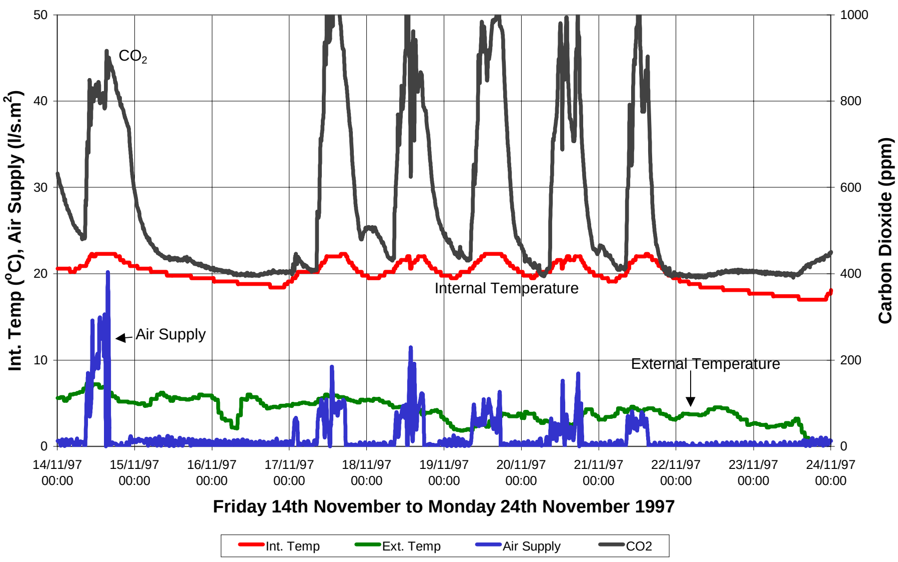

Figure 6: Winter Monitoring Results in Office 2

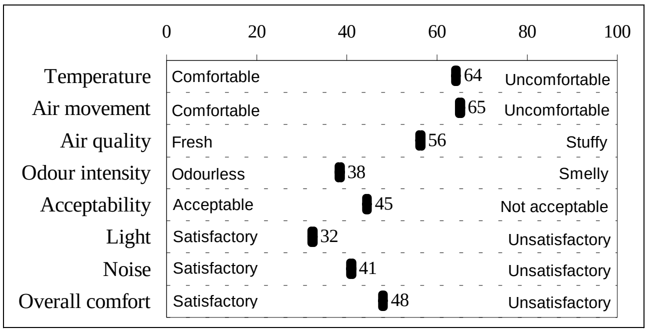

Figure7: Occupant Evaluation (Summer)

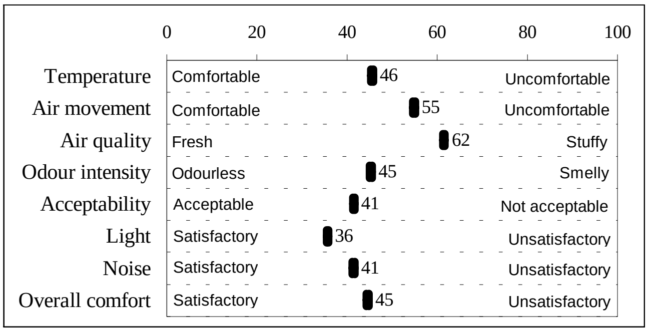

Figure8: Occupant Evaluation (Winter)

conditions in their office during the summer (Figure 7) and winter (Figure 8). About 100 occupants responded.

During the summer the occupants reported some dissatisfaction concerning the indoor temperature and internal air movement. Some occupants resorted to the use of small desk fans to help stimulate air flow and improve thermal comfort.

A comparison of Figures 7 and 8 shows that occupants felt that the indoor temperature and air movement were more comfortable in winter than in summer. With regard to air quality, the occupants apparently rated the summer situation more positively. The ratings are done on a relative scale and comparisons with ratings from other buildings should be made with great care.

Lessons Learnt and Suggested Improvements

Although high summer temperatures were recorded, the extensive use of solar shading and day-time window control ensured that the indoor air temperature rarely exceeded 29°C during the monitorng period. However, indoor temperatures were found to be consistently above the measured outdoor temperature, indicating that the night cooling potential of the building was not being achieved. This could probably be improved by introducing transfer grilles into each of the internal doors and considering the use of air intakes for the lower floors thus enabling cool air to enter the building without presenting a security risk.

Winter air change rate seemed to be close to the minimum required for adequate indoor air quality.

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The NatVent Project

Natvent is aimed at reducing energy consumption and carbon dioxide emissions by developing and demonstrating natural ventilation solutions. This project is targeted at climates in which overheating can be avoided by good architectural design and by minimising internal heat gains. By introducing natural ventilation, the complexities of mechanical systems and associated energy demand is eliminated, while the need for air conditioning is minimised. These case study summaries are intended to provide innovative examples of the use of natural ventilation and to demonstrate performance, pitfalls and solutions.

The NatVent Partners

Project Partners are:
Belgium: Belgium Building Research Institute,
Denmark: Danish Building Research Institute,
Netherlands: TNO Building Construction and Research, Delft University of Technology,
Norway: Norwegian Building Research Institute,
Sweden: J&W Consulting Engineers AB,
Switzerland: Sulzer Lab,
United Kingdom: Building Research Establishment, Willan Building Services.

European Joule Project

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