CHAM Limited
Pioneering CFD Software for Education & Industry

Building Ventilation in Sweden

PHOENICS Case Study – HVAC

Introduction
CHAM's Consultancy Team used PHOENICS/FLAIR for the analysis of a multi-storey building in the Kista region of Stockholm, Sweden. A model was created for testing the internal temperature distribution when subjected to worst-case winter and summer condition (very cold or very hot).

In particular, the customer was concerned about production of cold downdrafts in the building's atrium or along the large glassed façades during winter, and whether there were regions of unacceptably high air temperature during the summer time.

The building design was supplied to CHAM via a number of AutoCAD.DWG (Drawing) files of the building and its location, along with operational boundary data such as glass specification, building material, and internal heat sources, together with supplementary heating and cooling baffles, and an estimate of the number of people.

The geometry was created using PHOENICS VR-Editor (Virtual-Reality Graphical User Interface) based on the AutoCAD drawings as shown in the picture below.

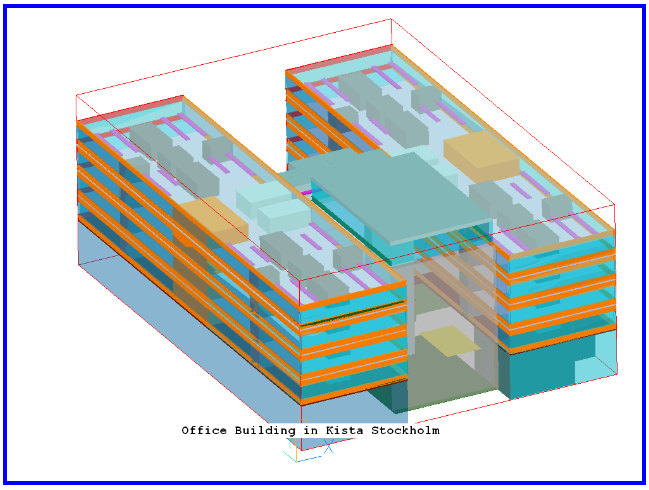

Figure 1: The geometry created within the PHOENICS-VR Editor

Problem Description
Eight offices were located on four floors either side of the atrium. Included within the model are some 650 objects representing doors, walls, roof, ceilings, glass windows, computers, persons, office furniture and various types of heat-sources. As Figure 1 shows, object distribution in all offices on each floor is similar thus 'copying' and 'arraying' objects taken from the database in the VR-Editor made geometry creation easy and fast.

To represent summertime conditions, a total solar heat gain of 46,580 Watt was specified through the glass doors and windows, with the radiation projected onto floors and internal walls. This was in addition to normal heat generated by people in the conference room and offices, and by lights and machines inside the building.

The temperature within the building was regulated by an air conditioning system introducing cooled air at 15°C, and a ventilation system generating a total air exchange of 2300 l/s throughout the building.

The winter case differed in that there was no solar heat affecting the temperature in the building; due to the low temperature outside, the glass door and all the glass windows take heat away from the building. The temperature of the ventilation air in the building was increased from 15°C to 18°C.

Results

A total mesh size of 1.1M cells was used, non-uniformly distributed over the entire calculation domain. A converged solution was obtained after 2000 iterations, which took 22 hours running the calculation on a 3MHz PC, and 8.5 hours on an equivalent 4-processor cluster using the parallel version of PHOENICS.

Figure 2 shows temperature distribution in the atrium during the summer. As may be seen, the temperature in most areas is around 22°C, which is similarly shown in Figure 3 by the 22.4°C iso-surface.

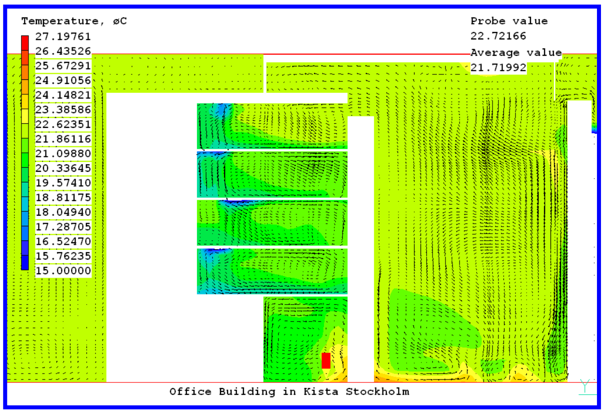

Figure 2. The temperature contours superimposed by velocity vectors at the vertical section in the middle of the atrium (Summer case).

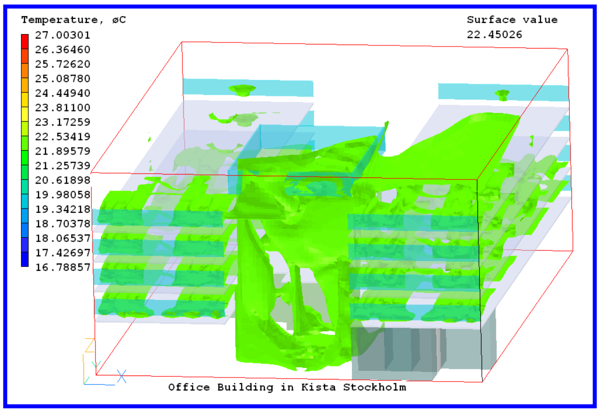

Figure 3. The iso-surface of temperature at 22.4°C degree (Summer case)

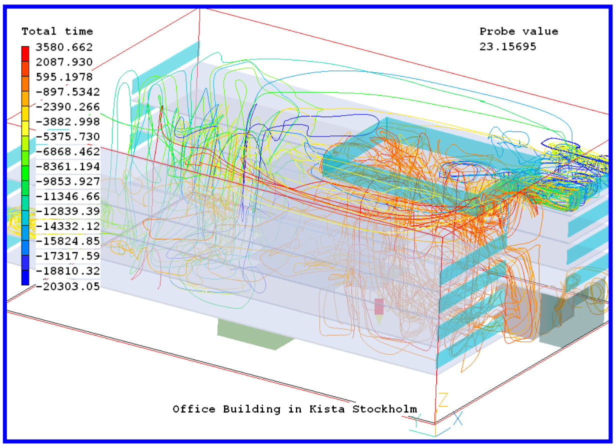

Figure 4. Streamlines starting from the middle of the floor of the atrium (Summer case)

Conclusion

These, and more-detailed, results were supplied to support evidence from CHAM's customer to demonstrate the effectiveness of the building's HVAC design under atypical weather scenarios.

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