scSTREAM

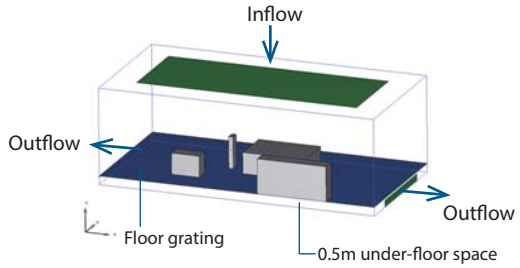
Cradle
MSC Software Company

Optimizing Opening Ratio for Clean Room Grating

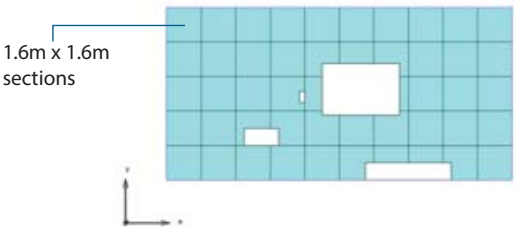
A properly designed clean room will produce a uniform downward air flow through the floor grating. Such air flow can be obtained by varying the opening ratio along the floor grate. scSTREAM is used to optimize the opening ratio for a clean room setup.

Model Overview

16m x 8m x 5m clean room



Top view of floor grating



Optimization Steps

(1) Before optimization

20% uniform opening ratio is set for the entire floor grating.

(2) Optimization

Pressure loss ΔP across the grating is modeled such that:

$$\Delta P = 0.5 Cf \rho V^2$$

where,
- Cf is pressure loss coefficient
- ρ is density of air
- V is airflow velocity

Opening ratio β at each point of grating is optimized for uniform downward flow by varying Cf. They relate to each other approximately as follows:

$$Cf = (5.375\beta^2 - 1.905\beta + 1.92)(1-\beta)/\beta^2$$

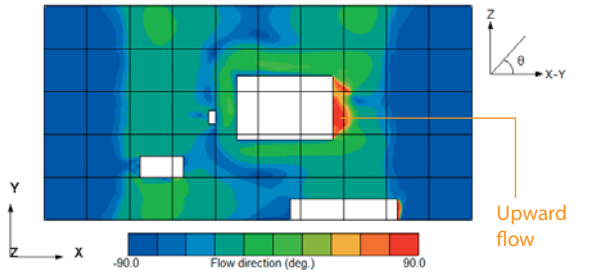
(3) After optimization

Different opening ratio is set to each section, based on the result of step (2).

Simulation Results

(1) Before optimization

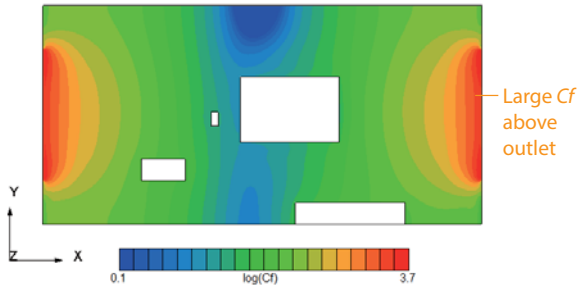
Flow direction θ through grating



Flow is non-uniform, and even some upward flow (red in the figure) is present.

(2) Optimization

Optimized Cf distribution (in log scale)



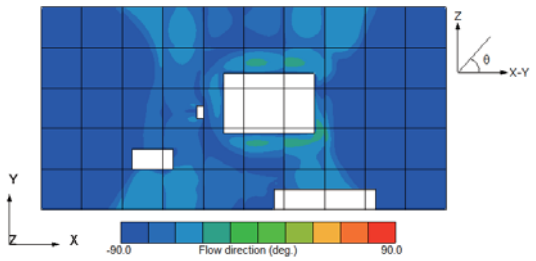
(3) After optimization

Section opening ratio [%]

7.6	9.2	12.3	20.4	53.4	38.9	18.5	12.0	9.1	7.5
3.7	7.6	11.2	18.7	33.3	27.7	17.3	11.1	7.5	3.7
3.7	7.0	10.7	17.5	28.1	N/A	16.4	10.7	7.0	3.7
3.7	7.6	10.9	17.6	29.4	25.1	16.4	11.0	7.6	3.7
7.6	9.2	12.1	18.1	32.8	24.5	15.6	11.5	9.7	8.0

Small opening ratio above outlet

Flow direction θ through grating



Compared to (1), flow is more uniformly downward, and no upward flow is present.

Notes

The opening ratio of a floor grating is optimized to produce more uniform downward air flow. The flow pattern can be further improved by dividing the grate into smaller sections.