



Buro Happold Specialist Consulting

Library of Birmingham

Environmental Modelling

Library of Birmingham

Project Value - £193M

Client - Birmingham City Council

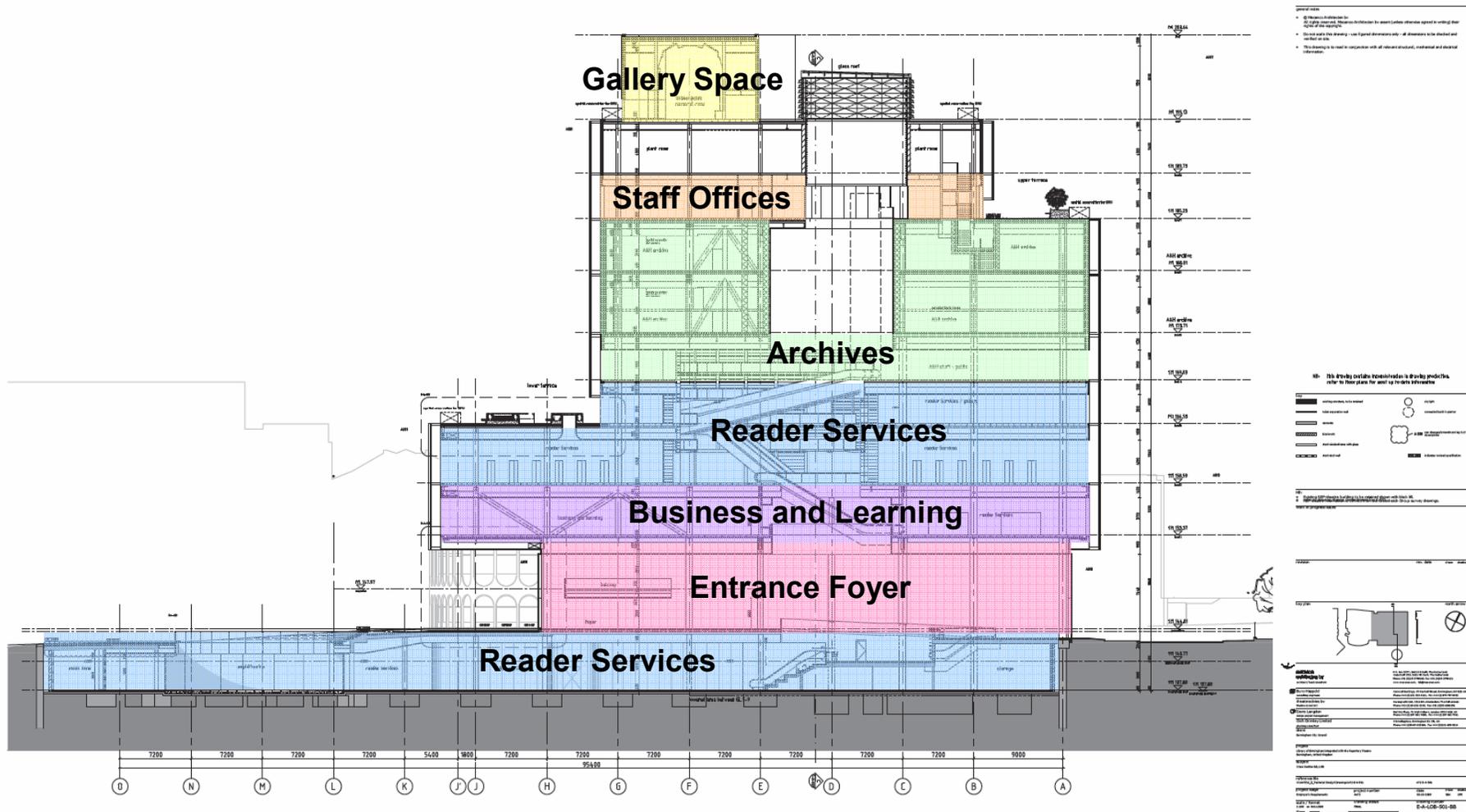
Architect – Mecanoo Architecten



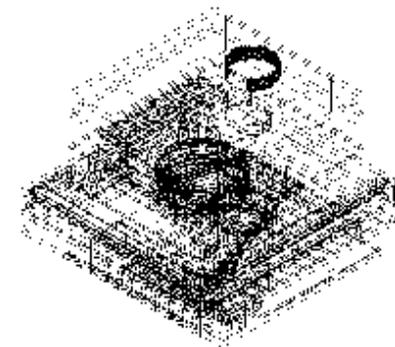
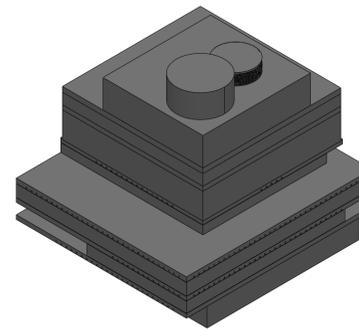
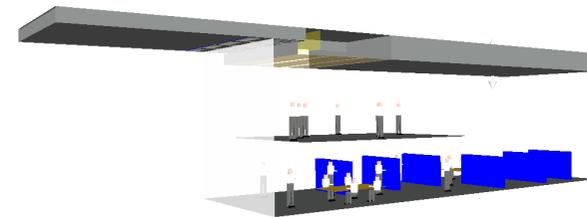
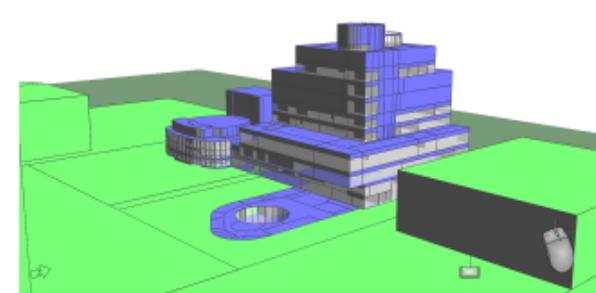
Buro Happold the engineering of excellence



Library of Birmingham – Building Functions



Modelling Packages

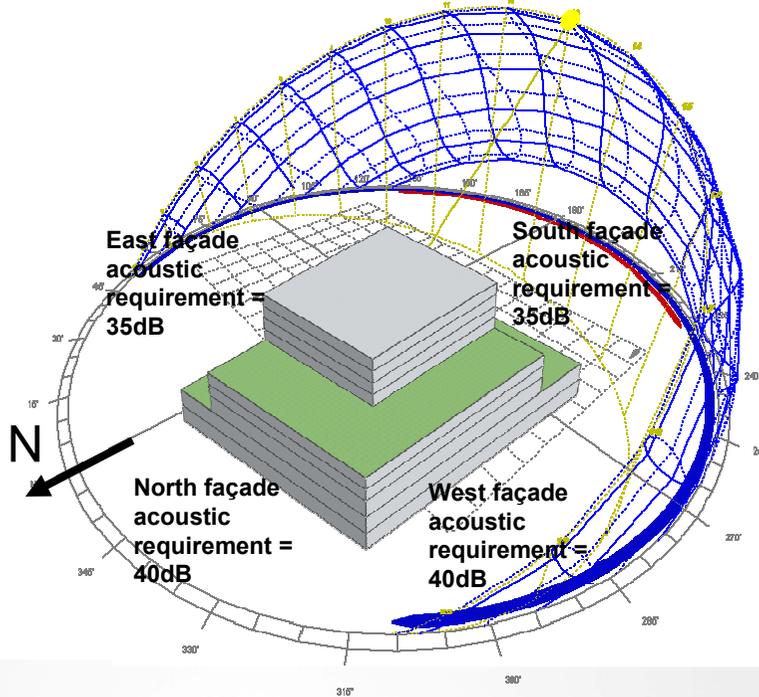


Ventilation Design Requirements

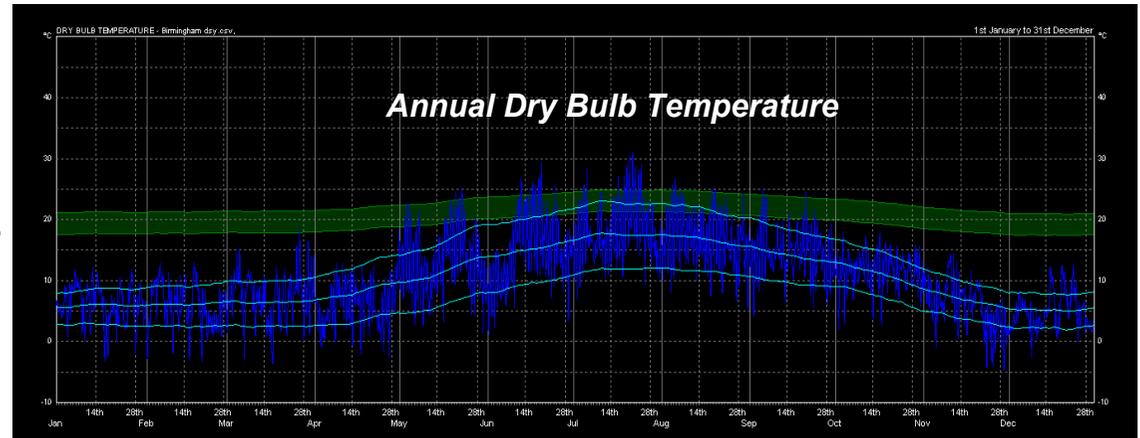
- BREEAM 'Excellent'
- Acoustics
- Ambient Conditions



Acoustic Requirements

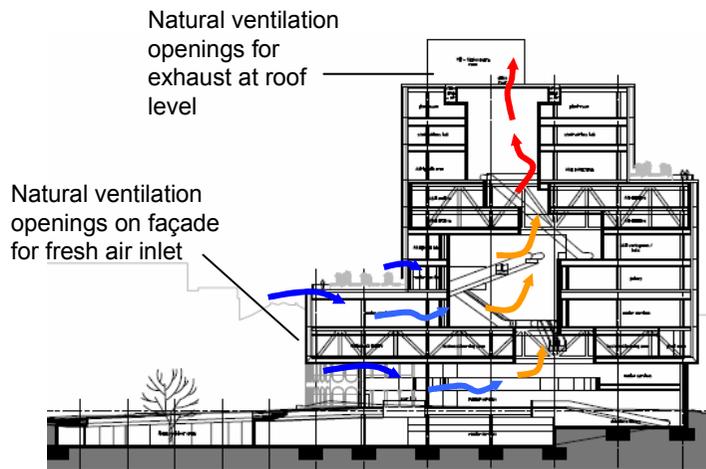
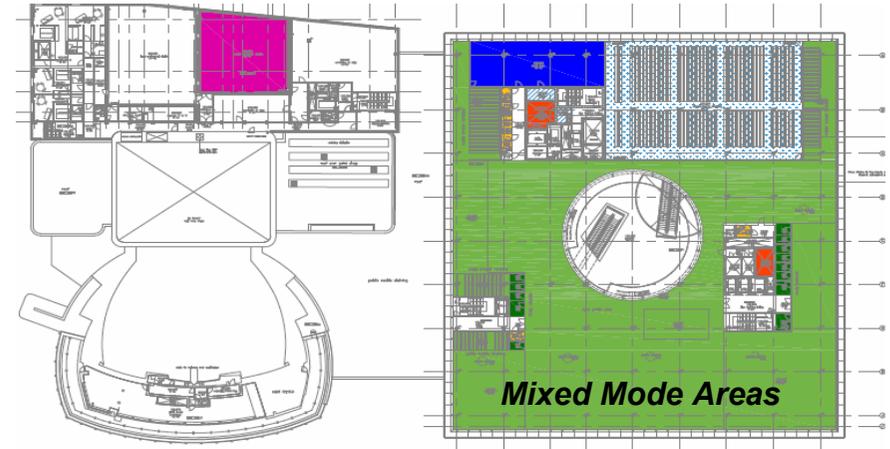


Site Constraints

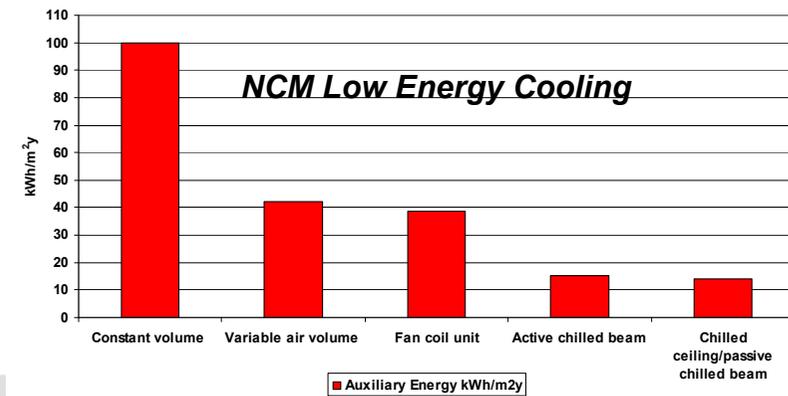
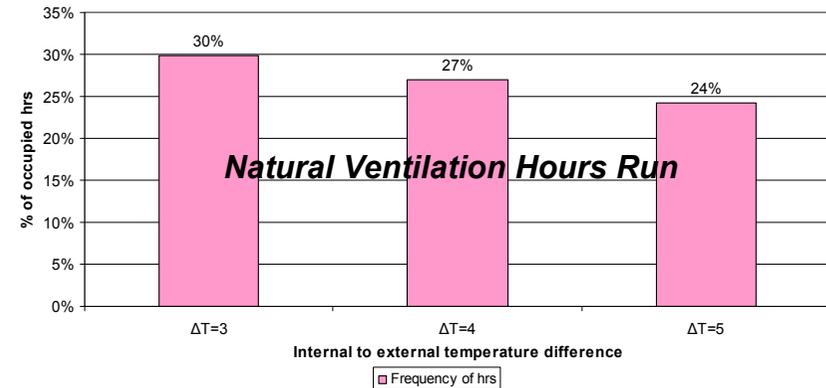


Ventilation Strategy

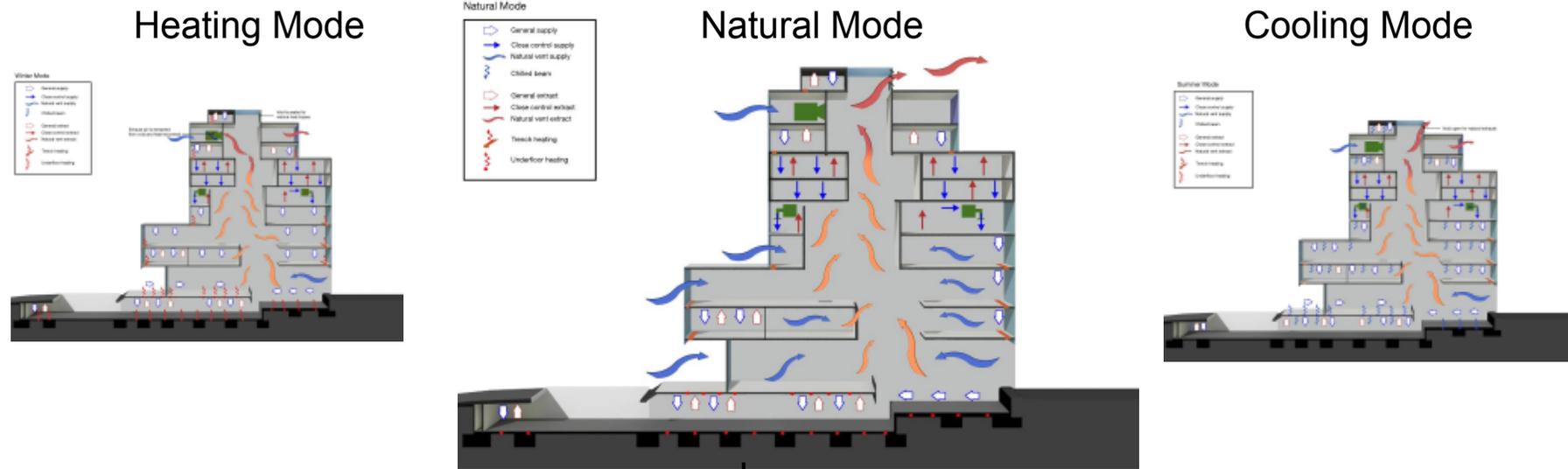
- Acoustic Louver – east/south/west
- Use of central stack for exhaust
- Maximise natural ventilation running hours
- Void Alignment
- Architectural Requirements
- Low Energy Cooling Strategy



Stack Ventilation Principal



Operation of Mixed Mode System



Louver Detail – *Occupancy Comfort, Permeable Ceilings*

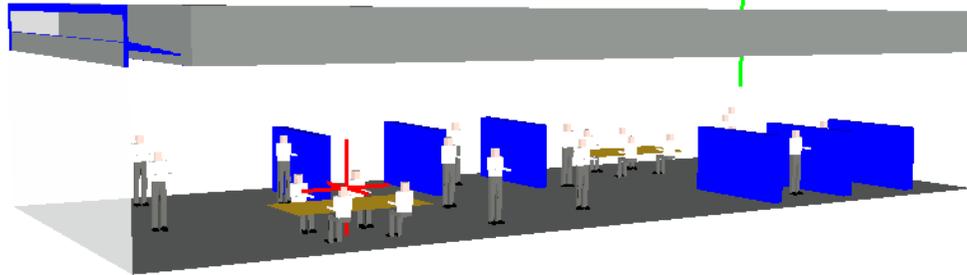
Whole Building - *Void Alignment*



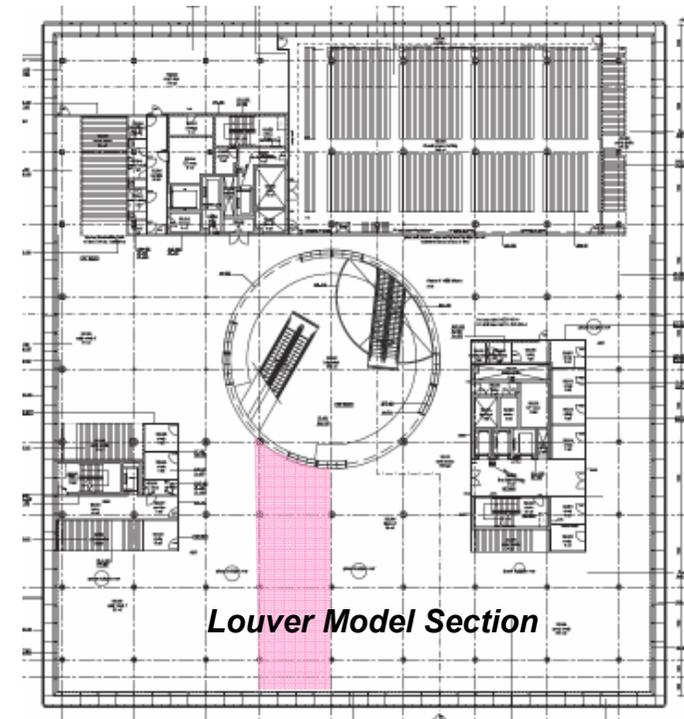
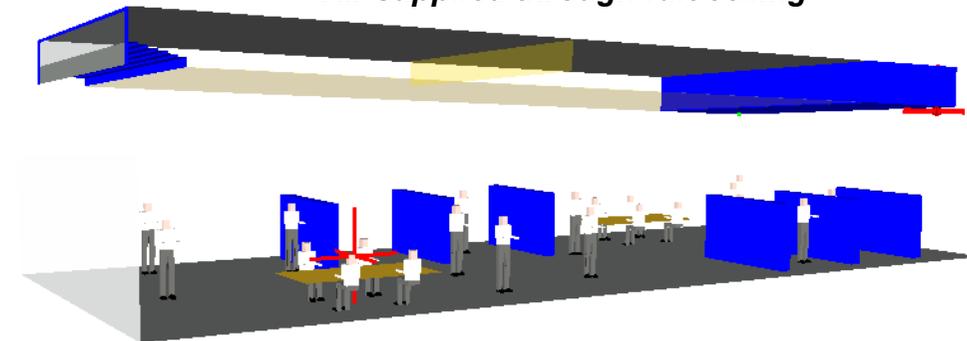
Louver Detail

- Air Supplied at Perimeter Only or Raft Ceiling
- Ambient Temperature 22°C
- Pressure Boundaries calculated from AM10

Air supplied at Perimeter



Air supplied through raft ceiling

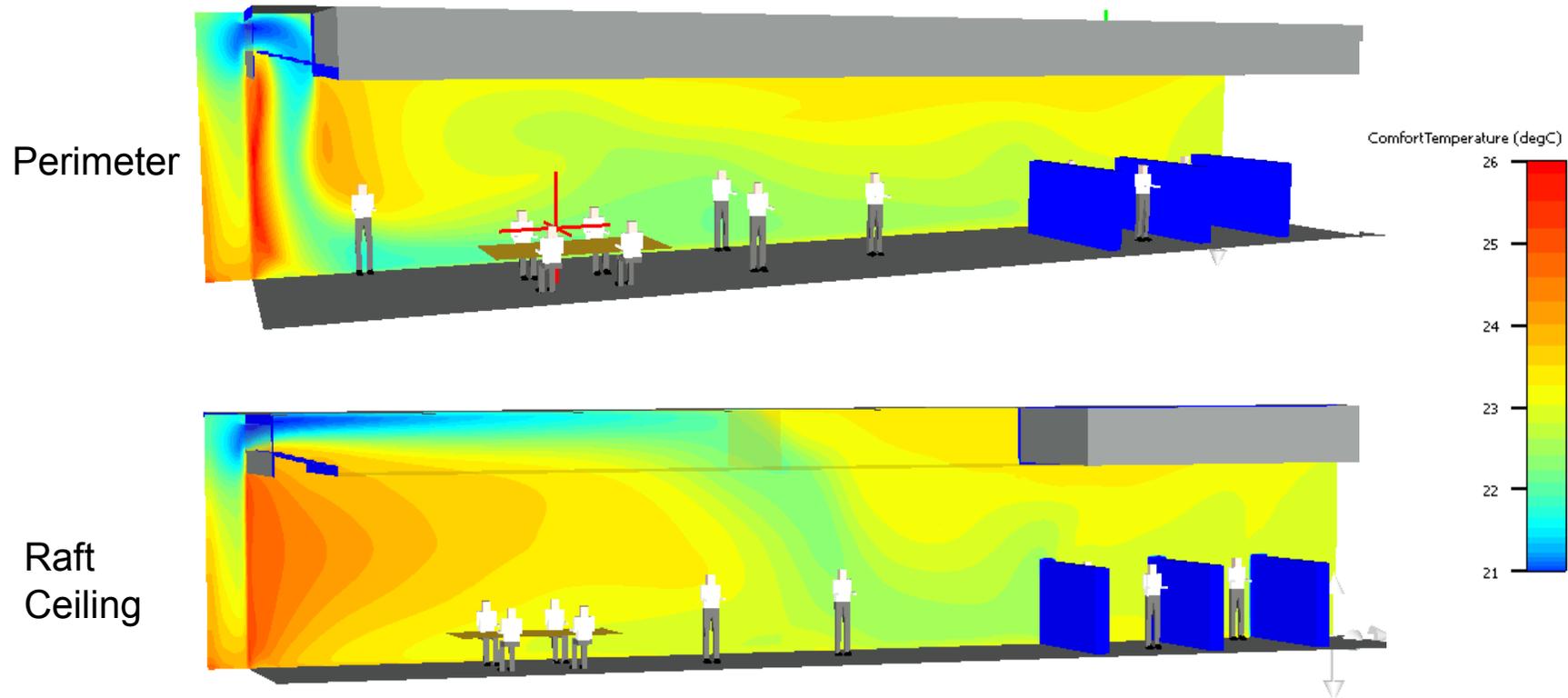


Louver Model Section



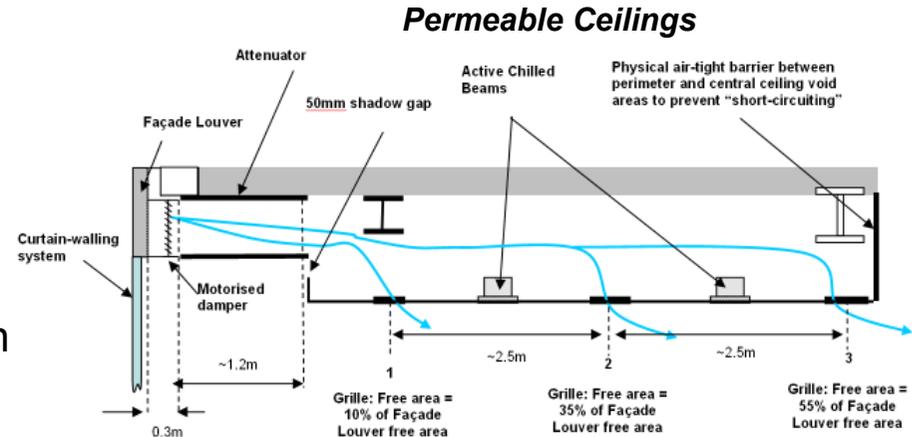
Louver Detail – Initial Analysis

- Cool air dumping with perimeter scenario
- High radiant temperatures with raft ceiling

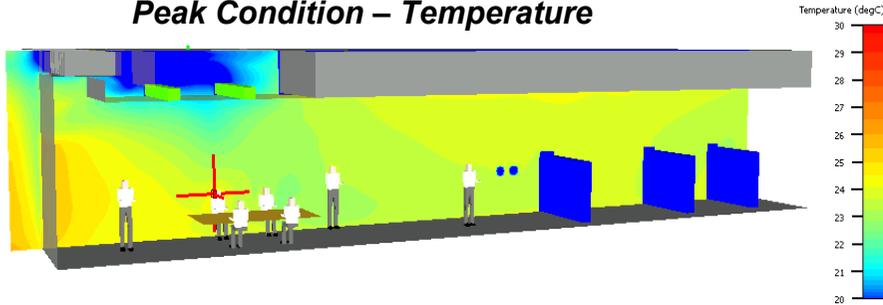


Louver Detail – Design Development

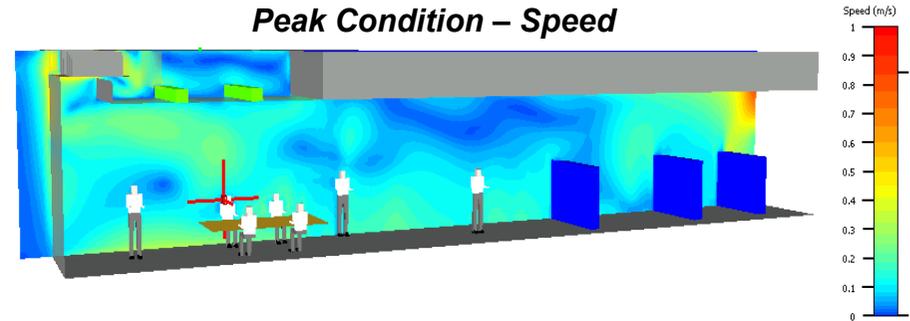
- Operation in Summer and Mid Season
- Permeable Ceiling Requirements



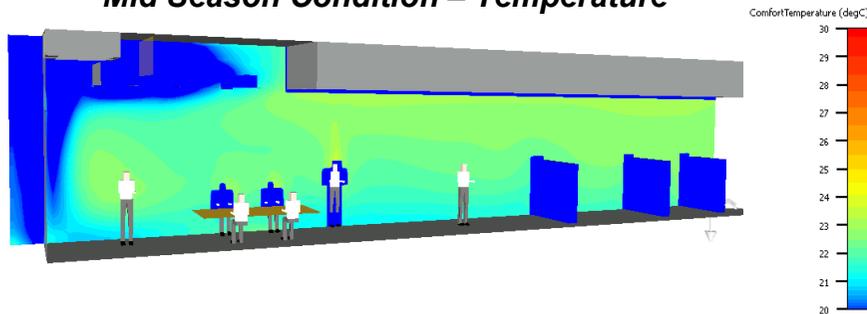
Peak Condition – Temperature



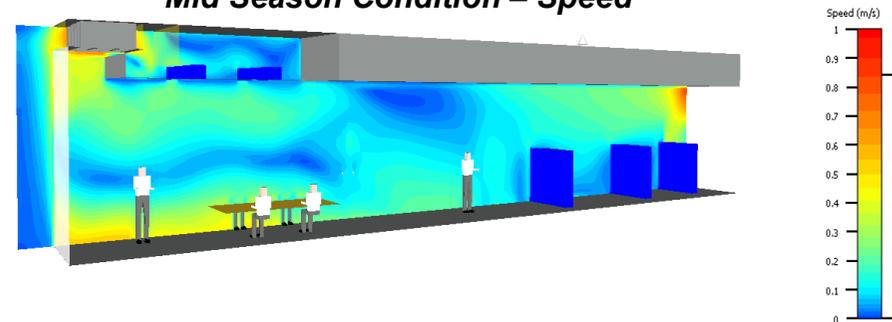
Peak Condition – Speed



Mid Season Condition – Temperature

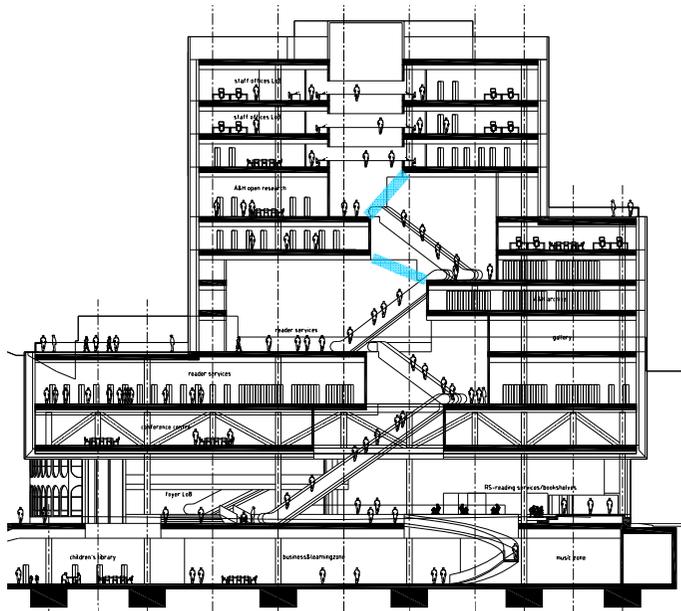


Mid Season Condition – Speed

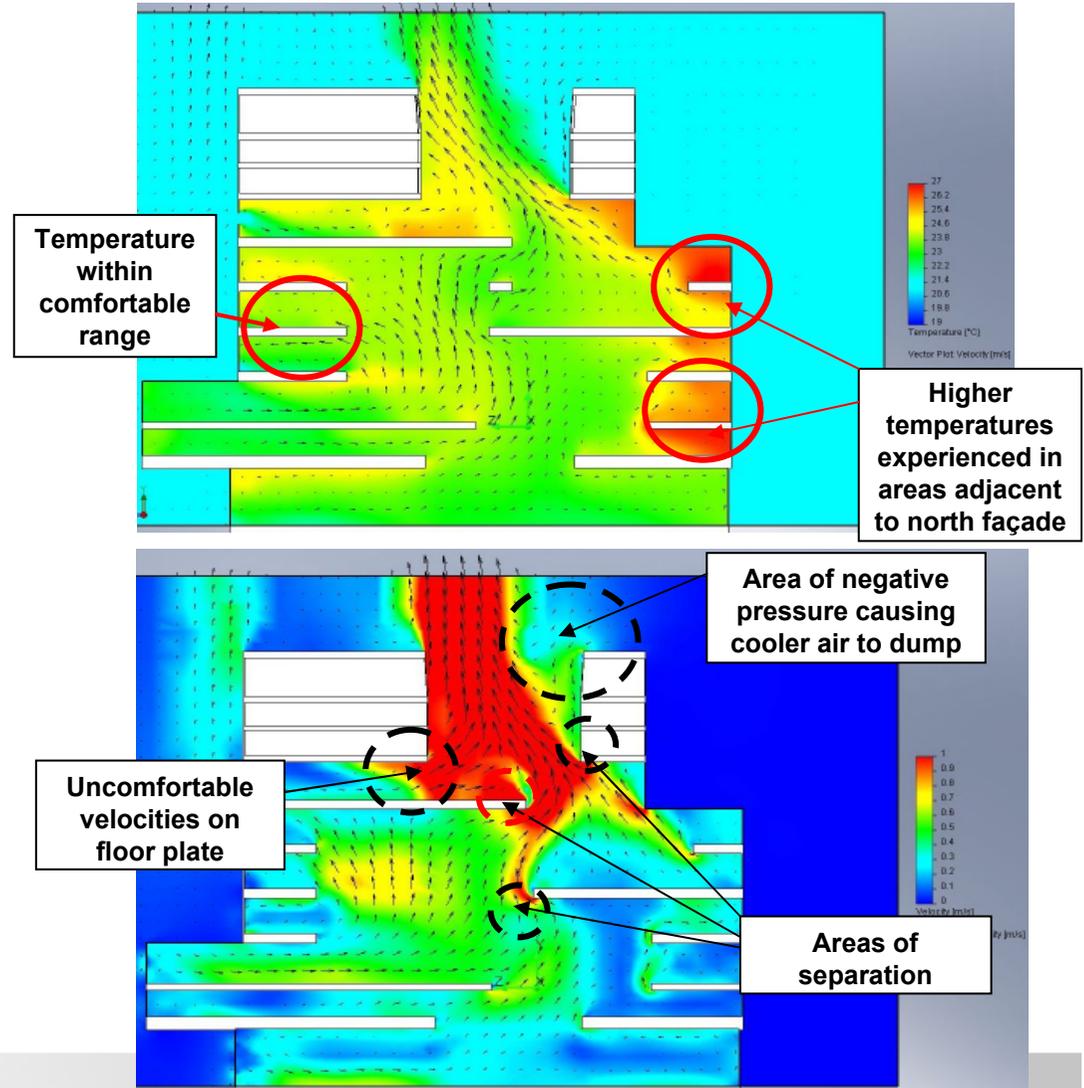


Whole Building – Void Alignment

- Ambient Temperature of 22°C
- Louver Free Areas from AM10

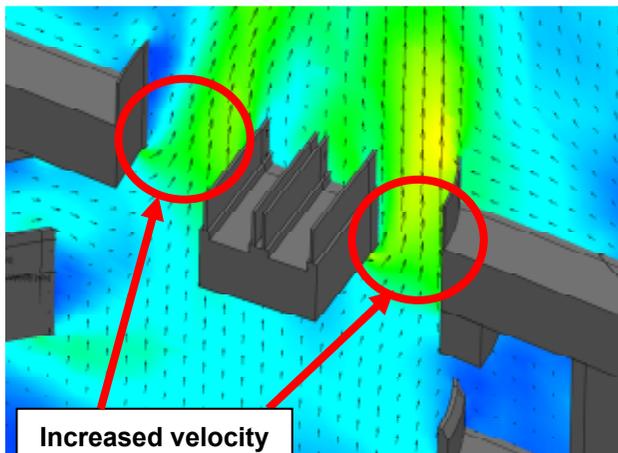


Void free area between 3rd and 4th no less than 69m² (N.B the current design at that point did not meet this)

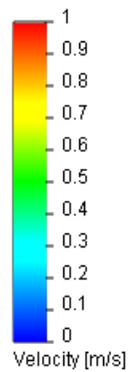


Whole Building – Void Alignment Design Development

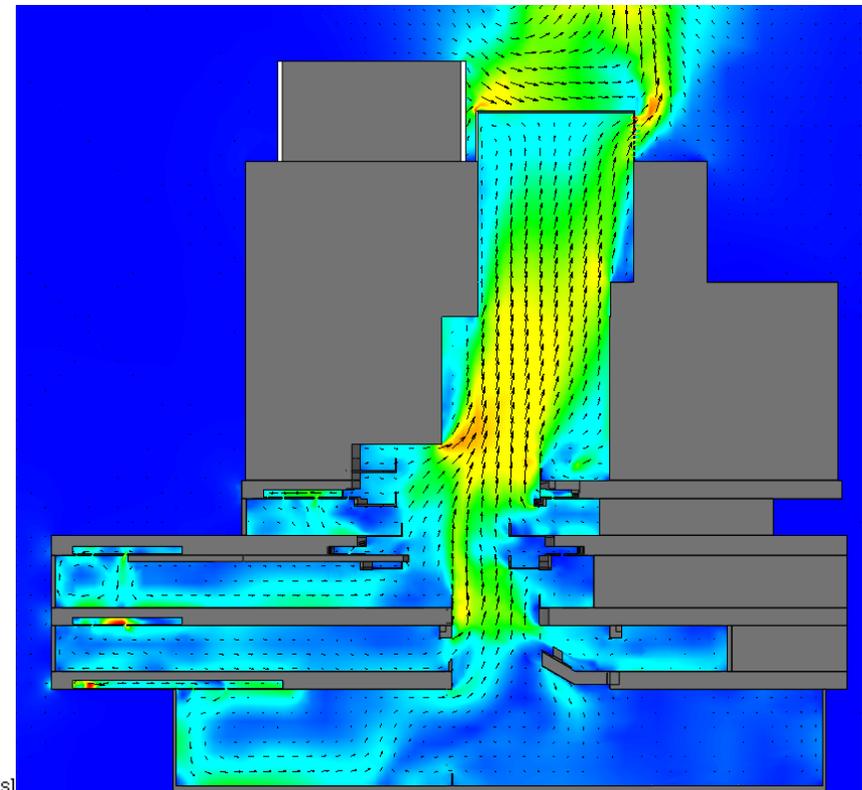
- Ambient Temperature of 22°C
- Design Requirement velocities less than 0.5m/s
- Inclusion of Escalators



Increased velocity
around escalator

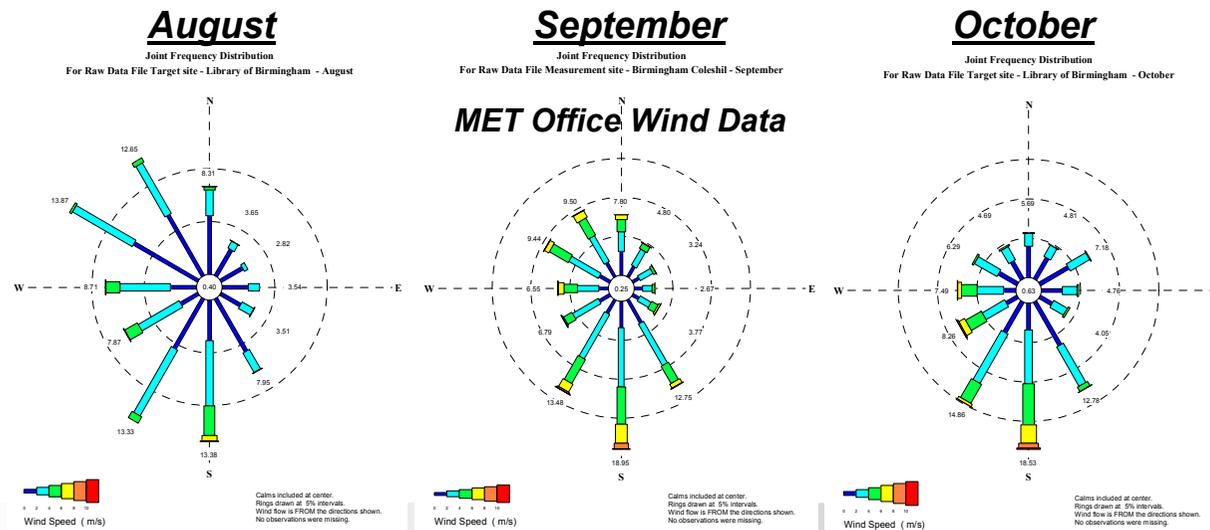
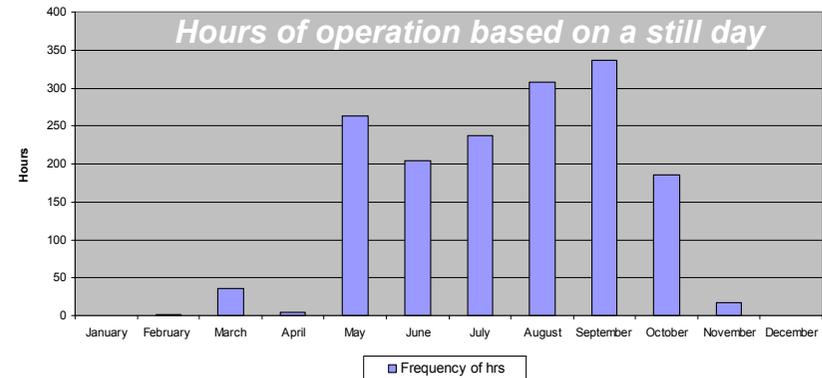


Vector Plot: Velocity [m/s]



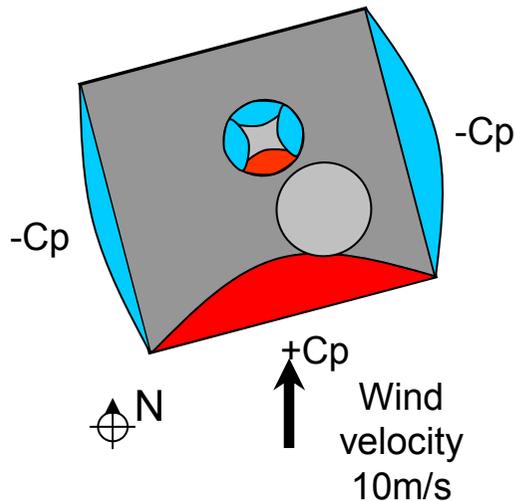
Whole Building – Natural Ventilation During Windy Conditions

- Concerns over operation during windy conditions
- Potential reduction in energy benefit
- Potential discomfort for occupants



Whole Building – Natural Ventilation During Windy Conditions

- Assessment of MET office wind data maximum wind speed 10m/s
- Pressure coefficients on each façade calculated
- Highest pressure coefficients on 3rd floor

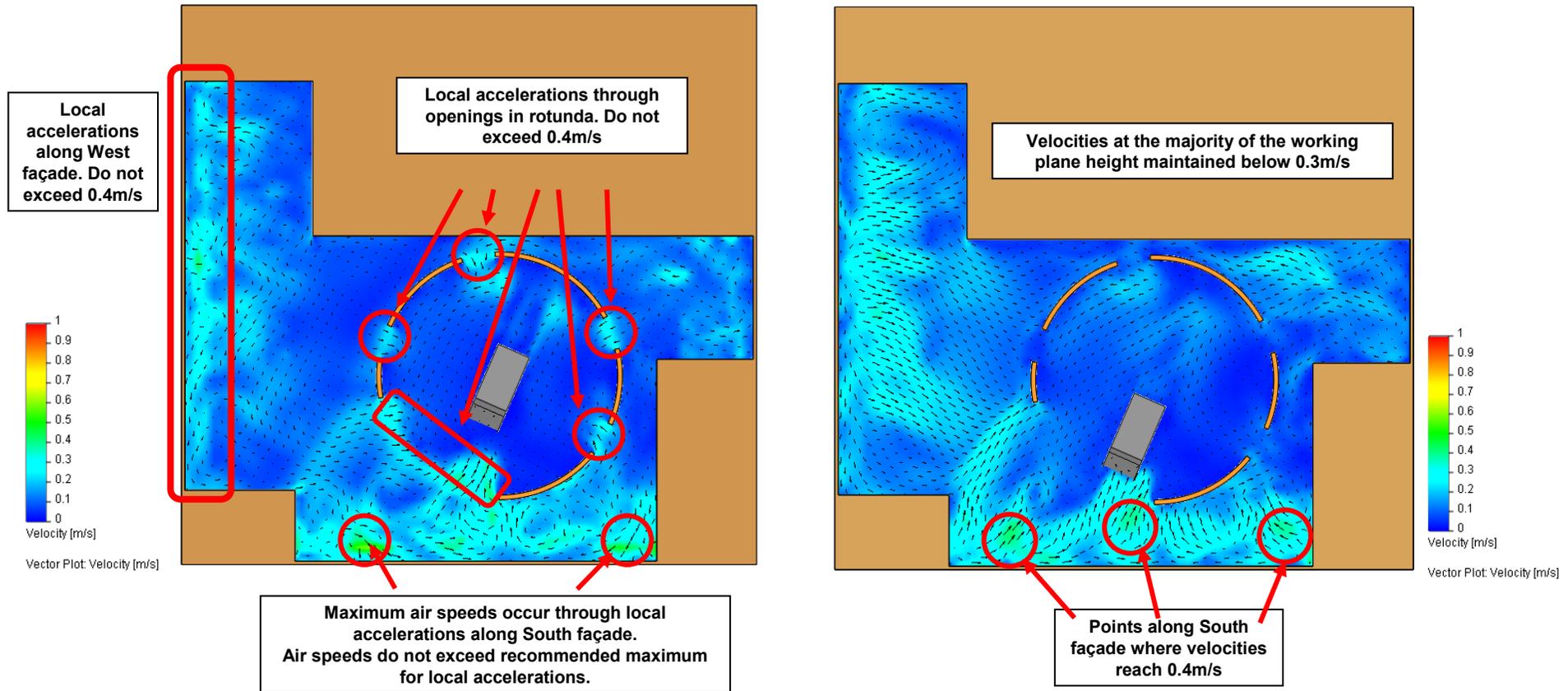


Level	Façade	Exposure level of inlet	Angle of attack (°C clockwise from normal)	Wind pressure coefficient
Ground	South	Exposed	22.5	0.25
1	East	Sheltered	112.5	-0.172
	South	Exposed	22.5	0.25
2	East	Sheltered	112.5	-0.181
	South	Exposed	22.5	0.313
	West	Sheltered	292.5	-0.057
3	East	Semi-exposed	112.5	-0.348
	South	Exposed	22.5	0.313
	West	Semi-exposed	292.5	-0.11
Roof	North	Exposed	202.5	-0.303
	East	Exposed	112.5	-0.533
	South	Sheltered	22.5	0.106
	West	Exposed	292.5	-0.213



Whole Building – Natural Ventilation During Windy Conditions

- Velocity contour plots at head height and working plane



Conclusions

- Comfortable conditions can be achieved throughout the range with permeable ceiling configuration
- High speeds restricted to voids
- High wind speeds do not cause discomfort as louvers have modulating dampers
- Control system installed is capable of understanding the external weather conditions, and on the basis of this is capable of intelligently controlling the openings on each façade and rooflight orientation proportionally and independently



Questions

