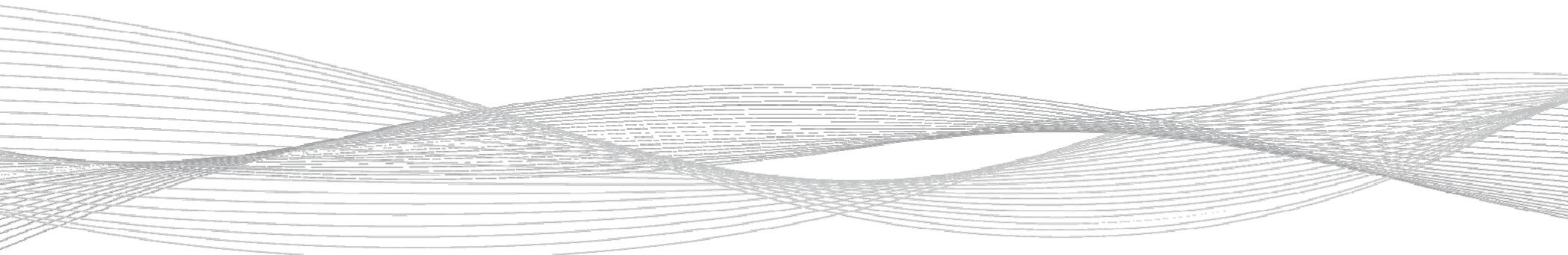


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consulting engineers

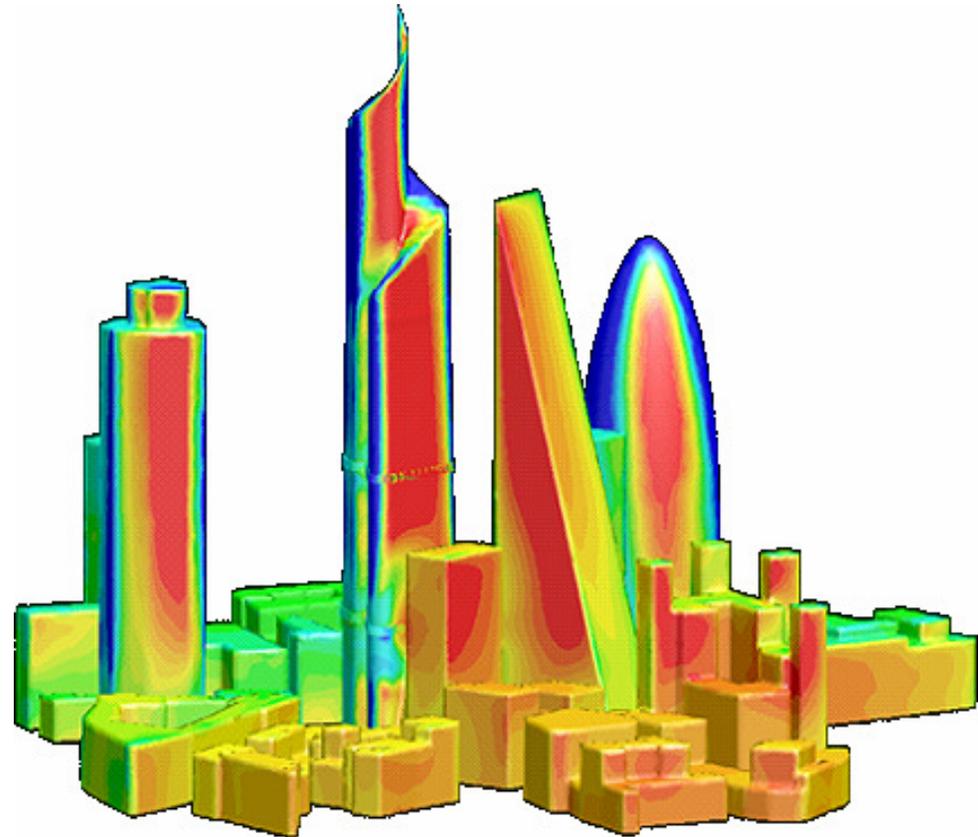
A decorative graphic consisting of multiple thin, grey, wavy lines that flow across the page, creating a sense of movement and depth.

## Thermal and Mixed Mode Approaches to CFD Modelling of The Pinnacle's Externally Ventilated Facade

Presentation to  
CIBSE BSG Natural Ventilation and Mixed Mode Modelling Seminar  
24 May 2010

# Presentation Overview

- Company Background
- Scheme Summary
- Façade Concept
- Externally Ventilated Facades
- Thermal Analysis
- Building Aerodynamics
- Mixed Mode Analysis
- Conclusions



# Company Background

Building Performance & Services  
Engineers

30 years of experience

Over 230 professional staff

Over 5000 completed projects

Experience in wide range of  
sectors

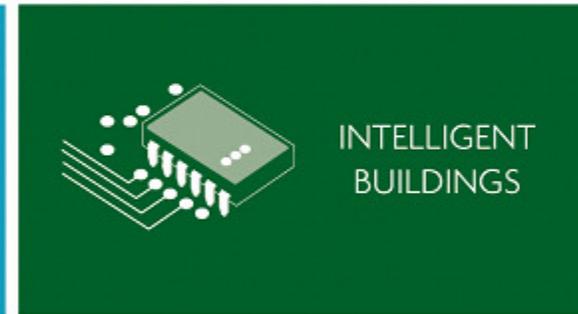
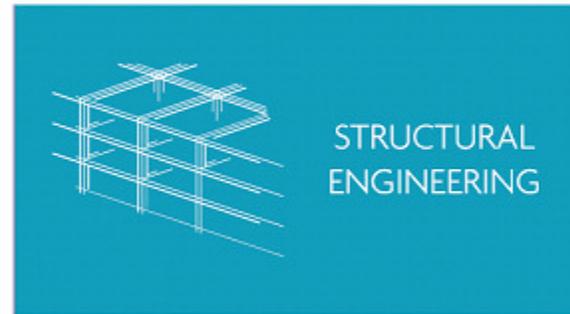
Offices:

**UK:**

London • Farnborough • Manchester

**Overseas:**

Milan, Italy • Paris, France • Abu  
Dhabi, UAE



# Scheme Summary

High quality speculative office development

Set to be the highest tower in the City of London

93,000m<sup>2</sup>

288m tall

Environmentally progressive design goal

Strong passive design with 'Mixed Mode' ventilation and decentralised plant strategy

Low energy/CO<sub>2</sub> rating + future proofed

Extensive design development work conducted pre-planning

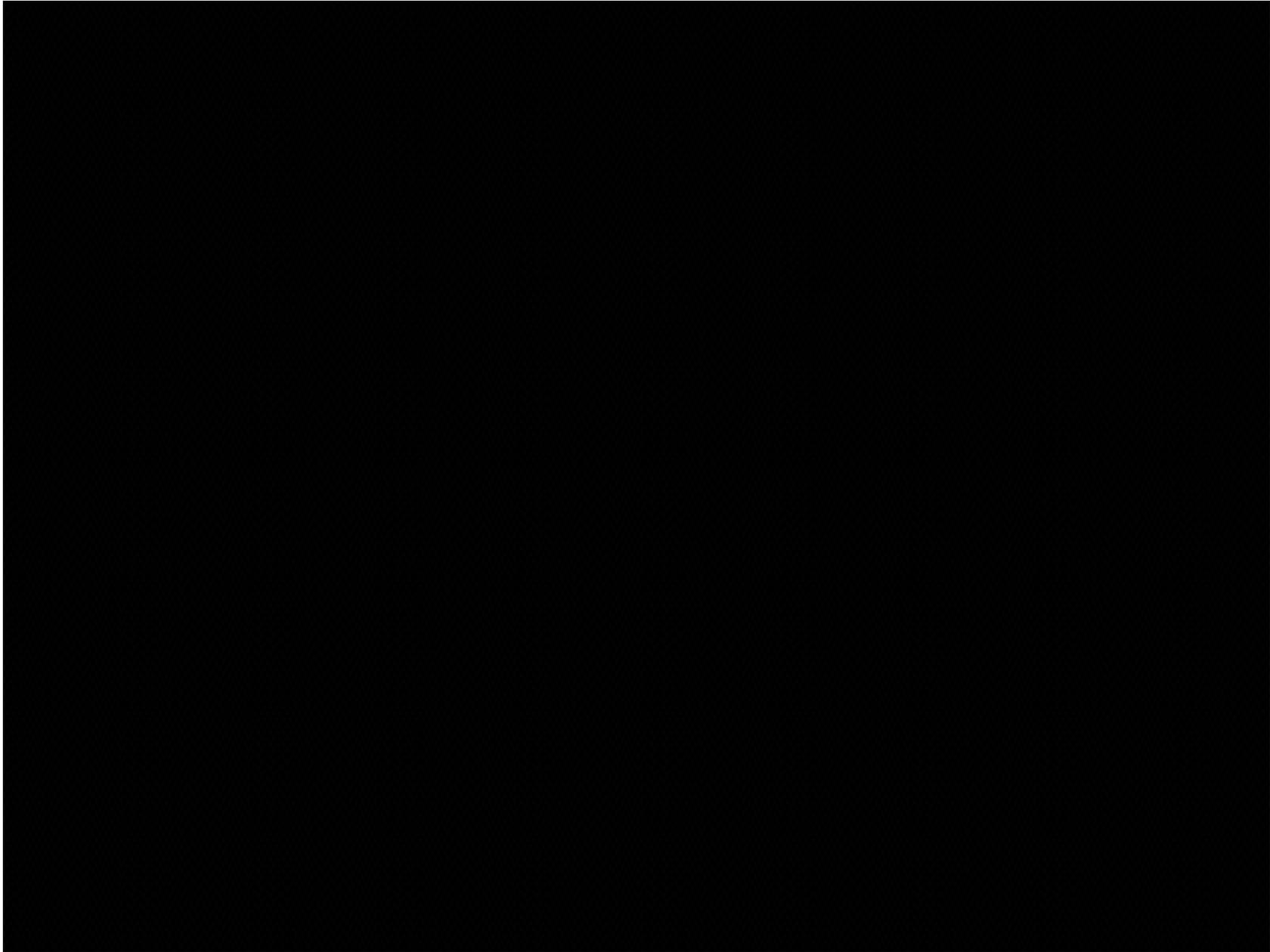
Designing from outside and working in

BREEAM target 'Excellent'

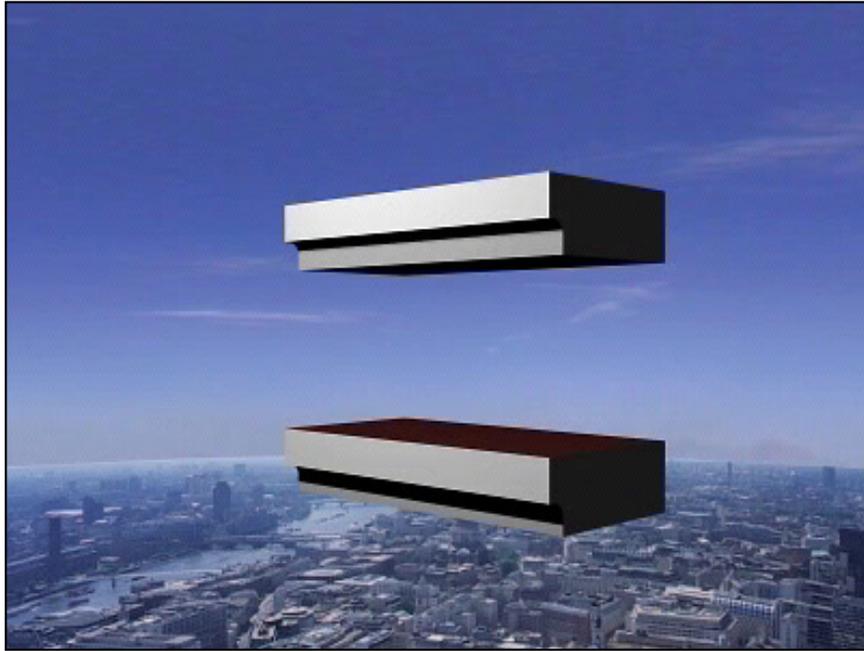
Significantly exceeds Part L 2006 requirements



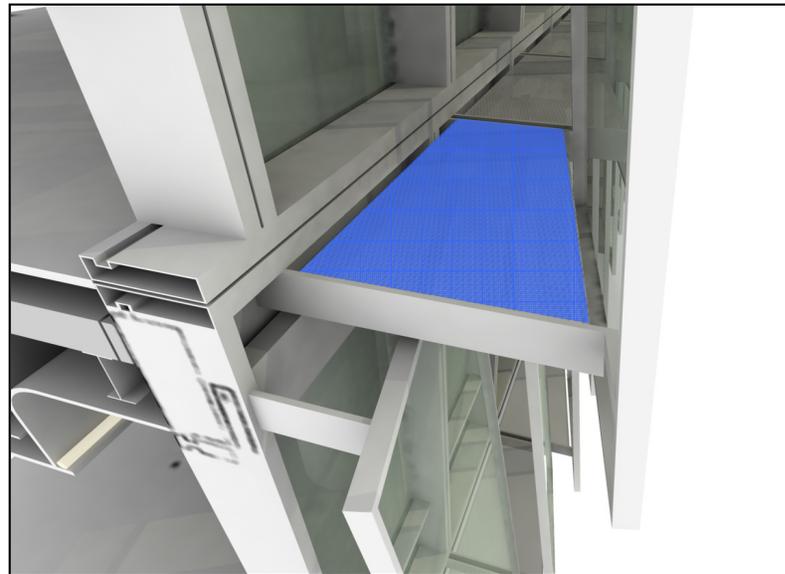
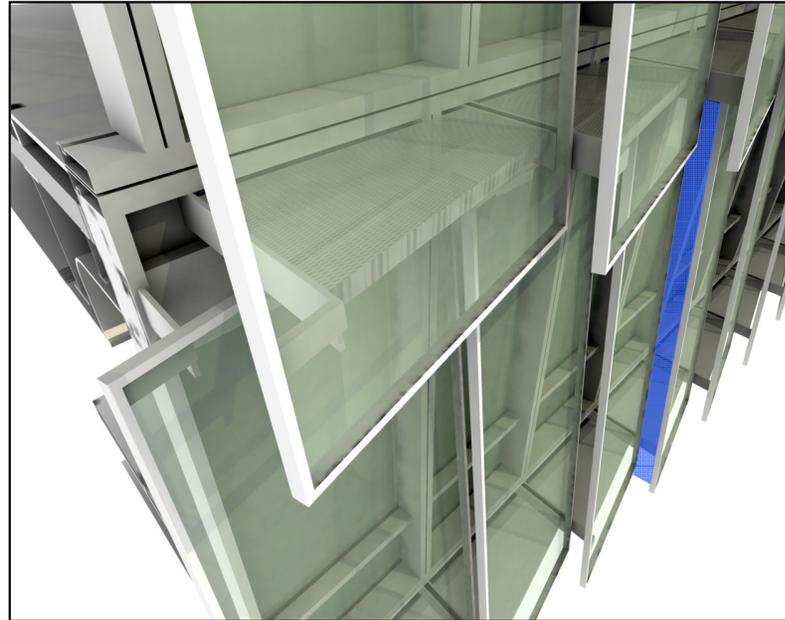
# Building Massing



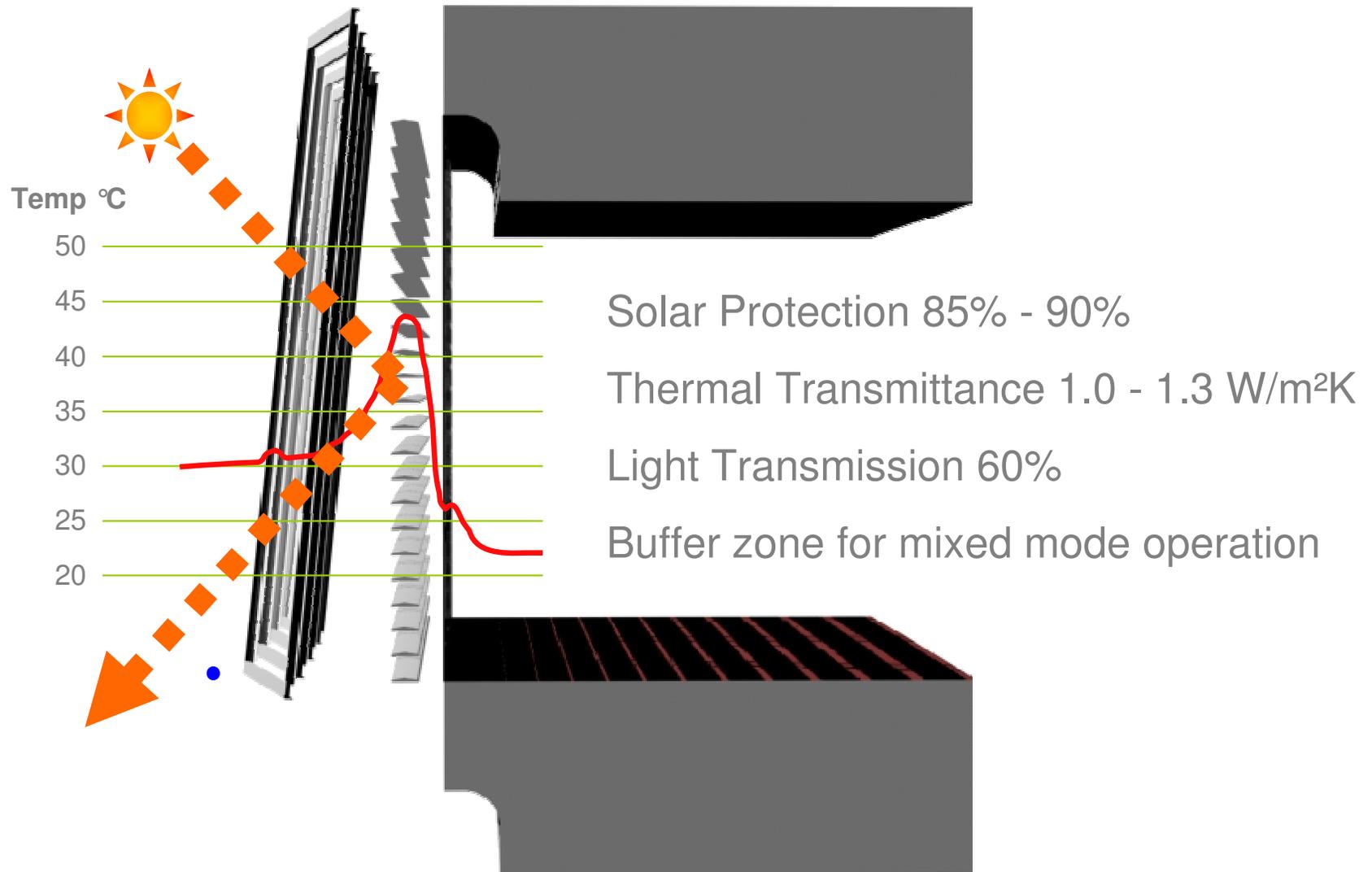
# Façade Concept



Animation by Hilson Moran



# Externally Ventilated Facades



# Thermal Analysis

Investigation of façade performance for 'worst-case' thermal scenario

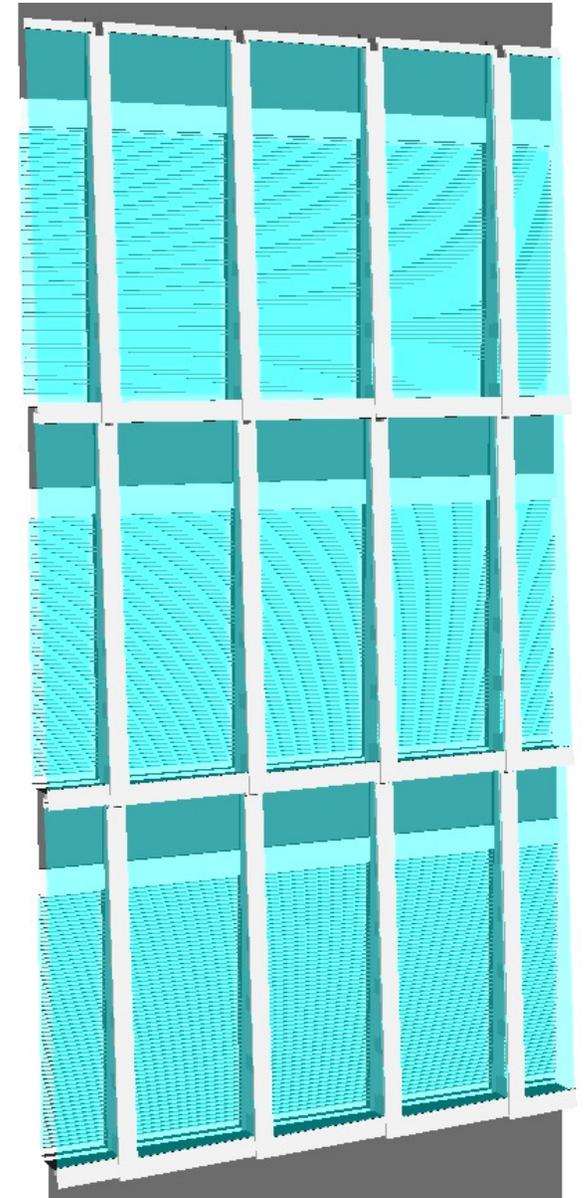
- Hot summer day – 30°C
- No wind
- No cloud cover

Model included

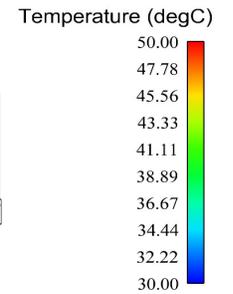
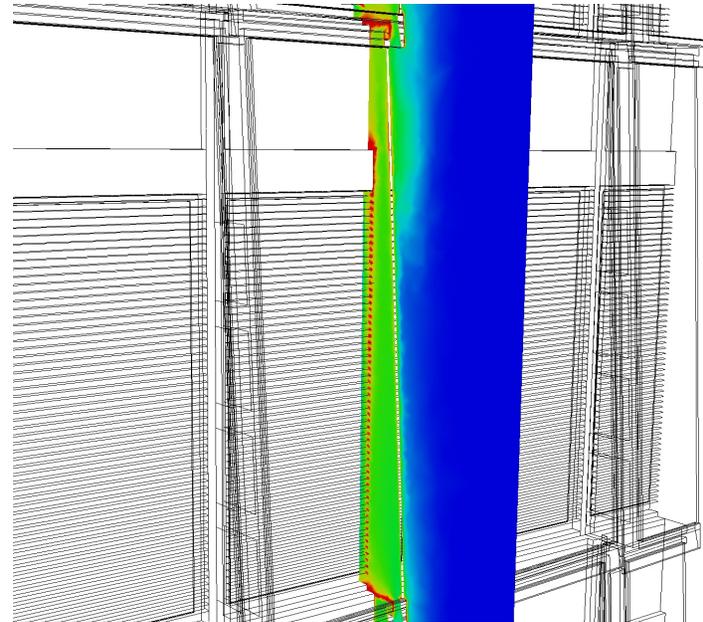
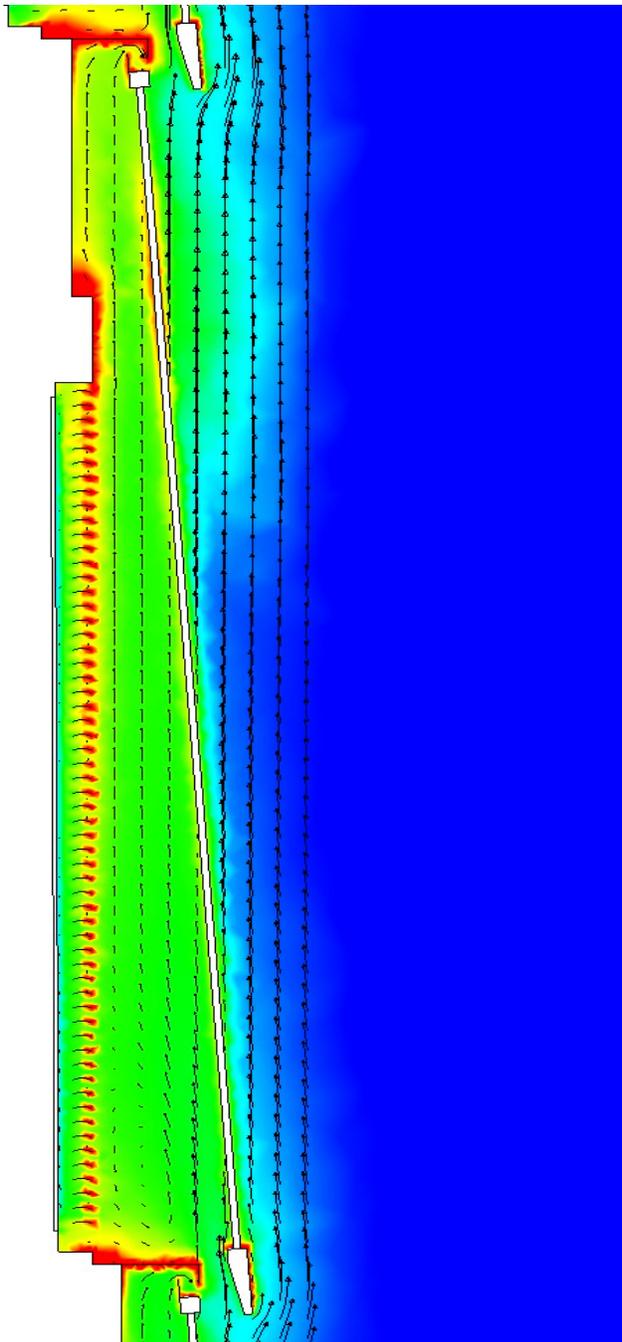
- Glazing properties
- Blinds
- Framing and structural elements
- Windows closed

Solutions details

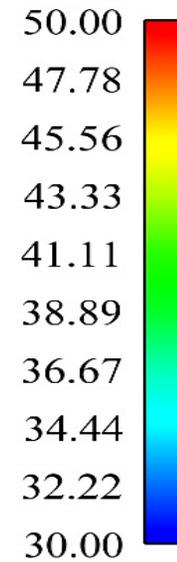
- 14.5 million cells
- Solar ray tracing model & radiation modelled



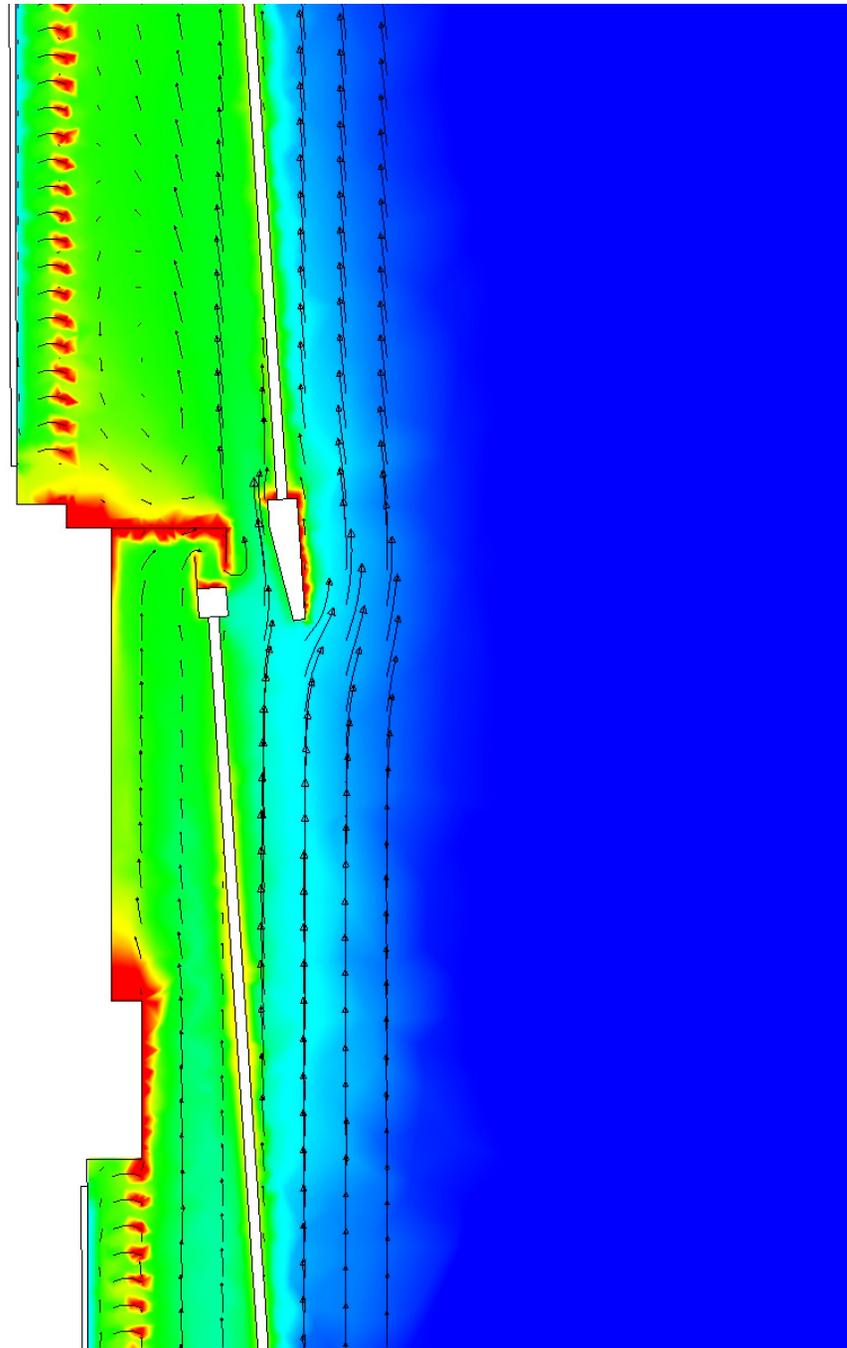
# Thermal Analysis



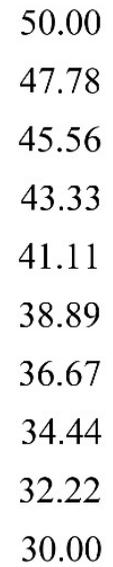
Temperature (degC)



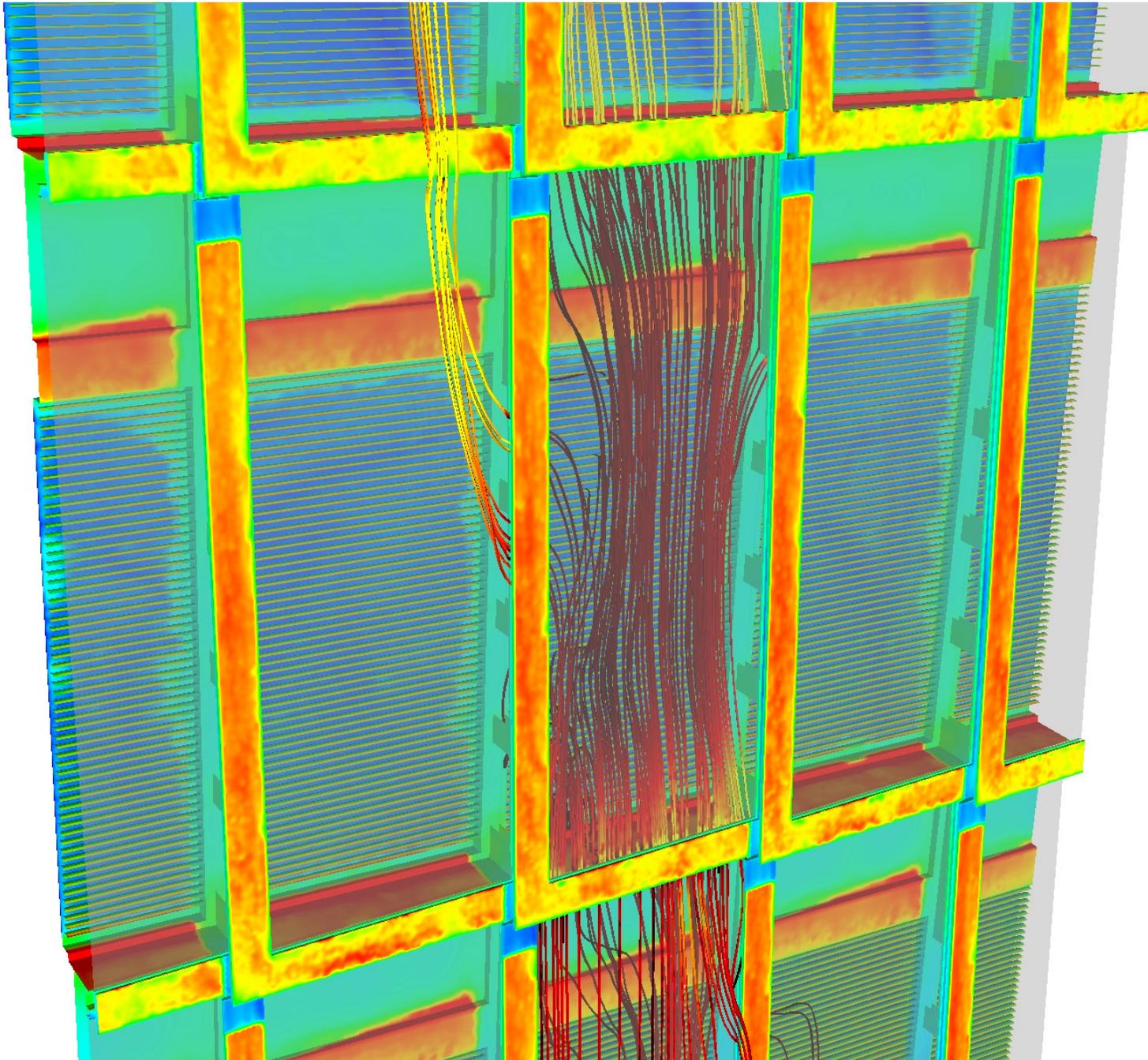
# Thermal Analysis



Temperature (degC)



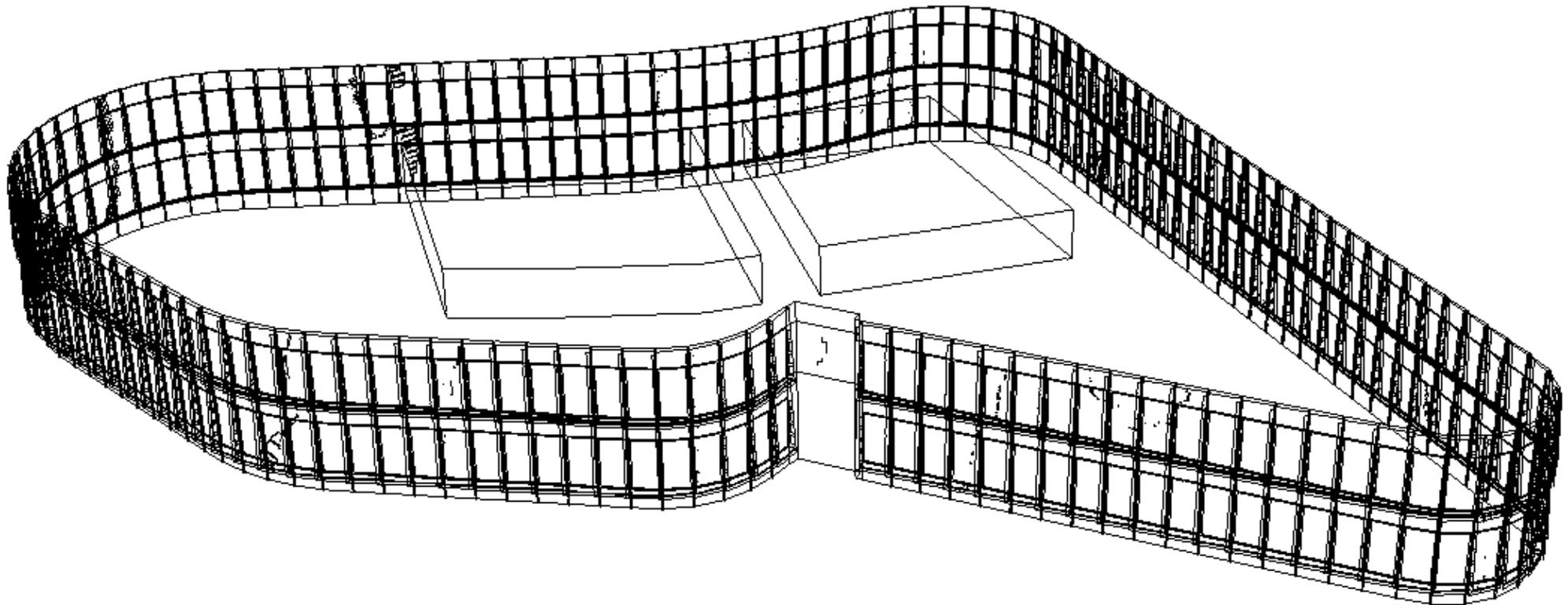
# Thermal Analysis



# Building Aerodynamics

Assessment of natural ventilation performance for whole floorplate

Same façade design applied to 41<sup>st</sup> floor, consisting of 130 façade modules



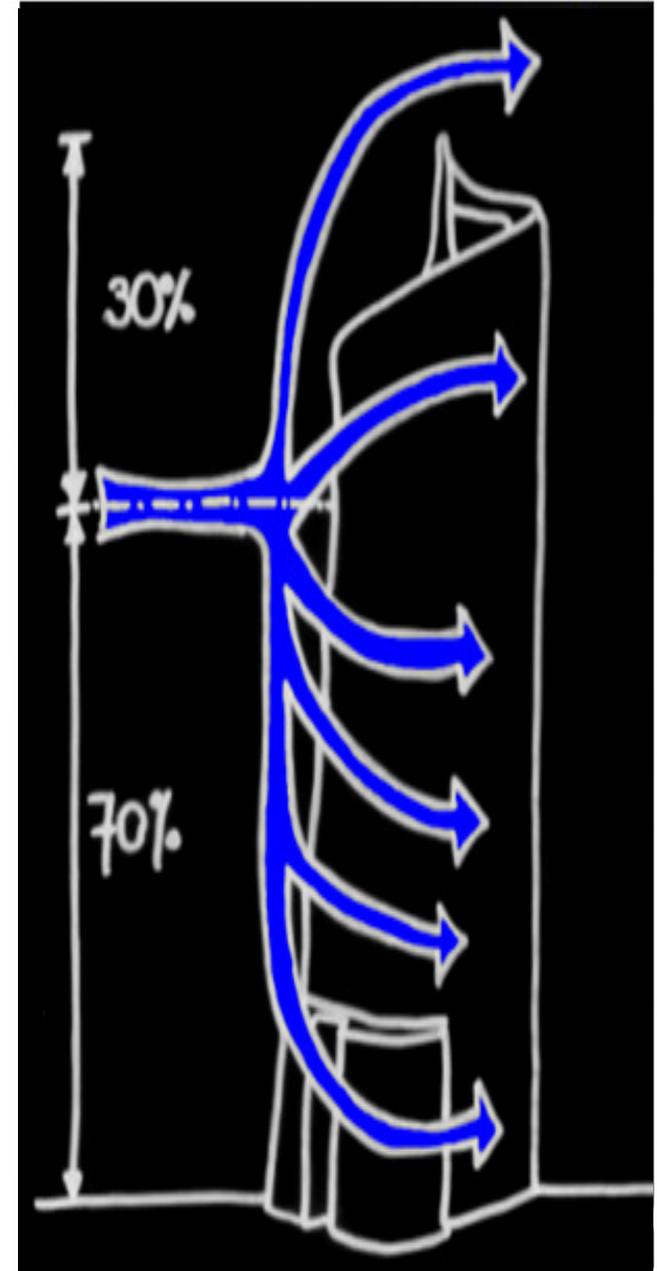
# Building Aerodynamics

Air path around a building depends on height – some goes up, some goes down

Neutral floor is the midpoint

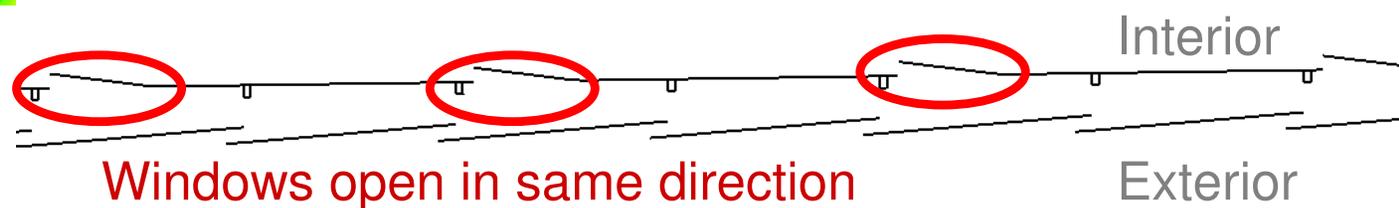
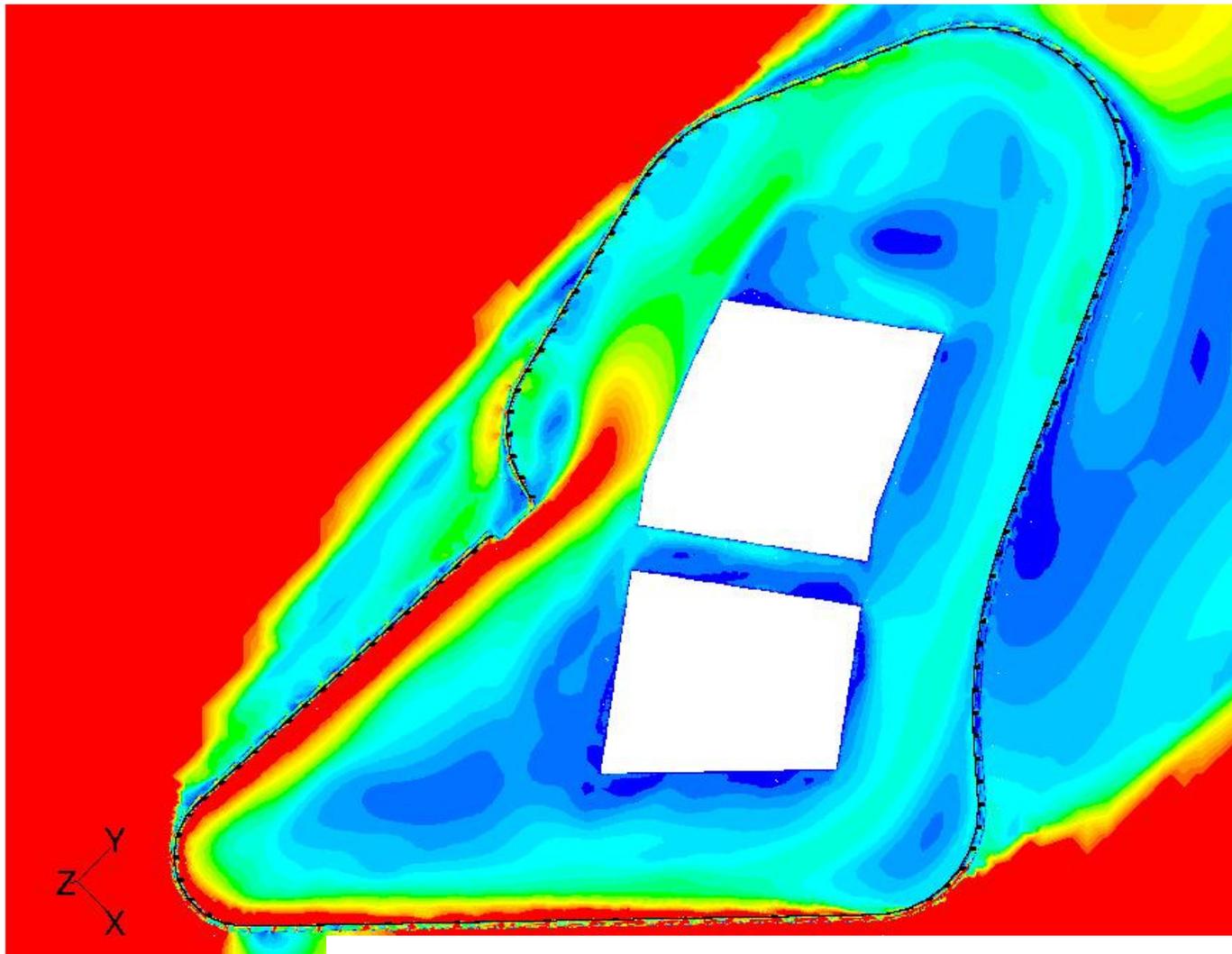
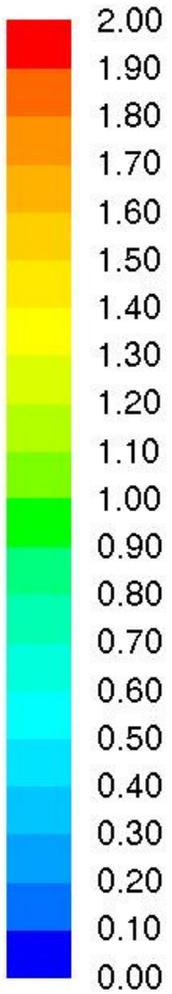
Previous aerodynamic studies have shown the split to be approx 70% down and 30% up for the Pinnacle

This allows the model to be much simpler

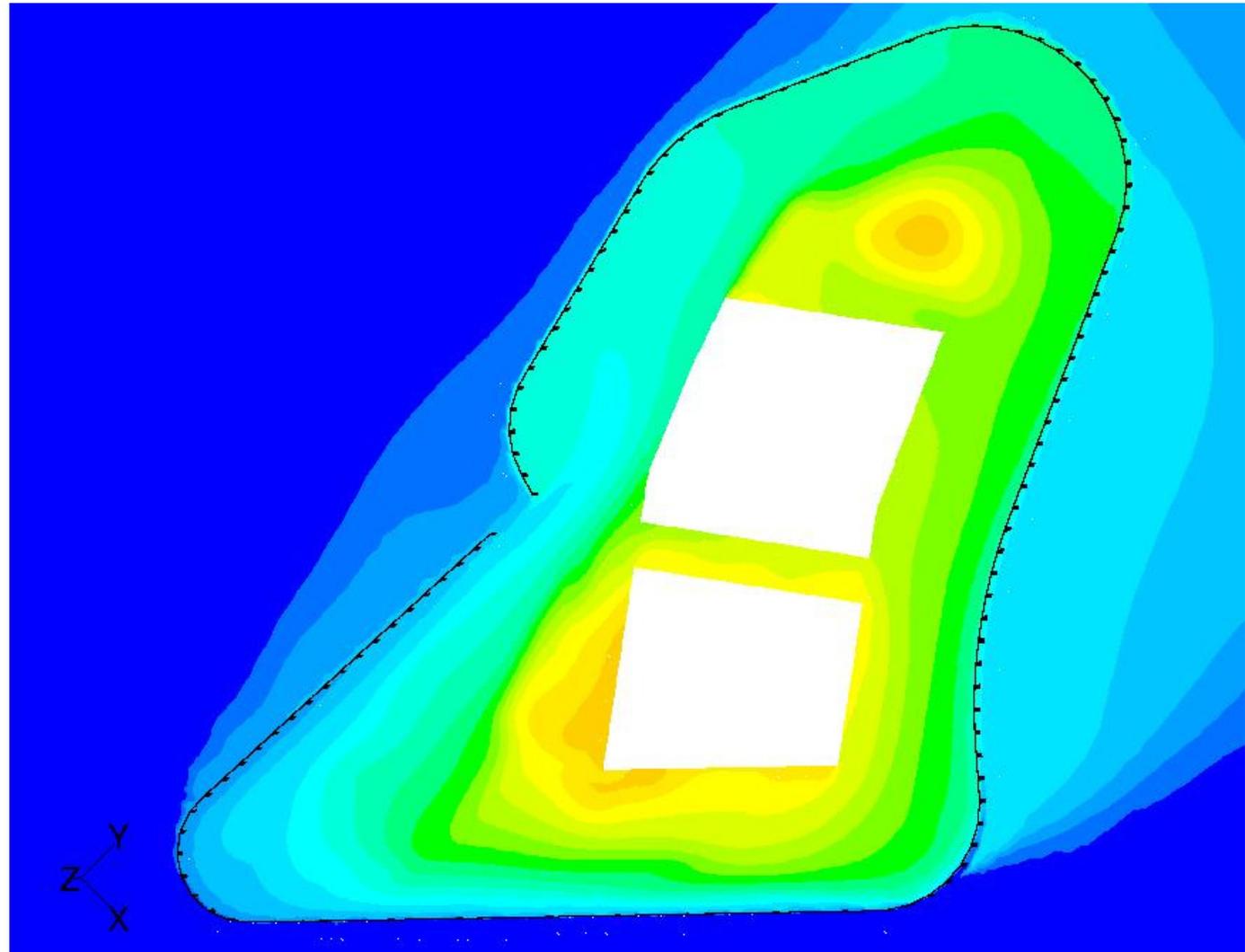
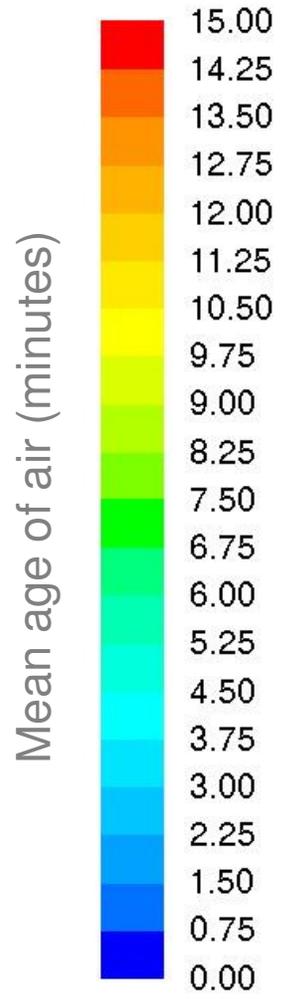


# Mixed Mode Analysis – South West Wind

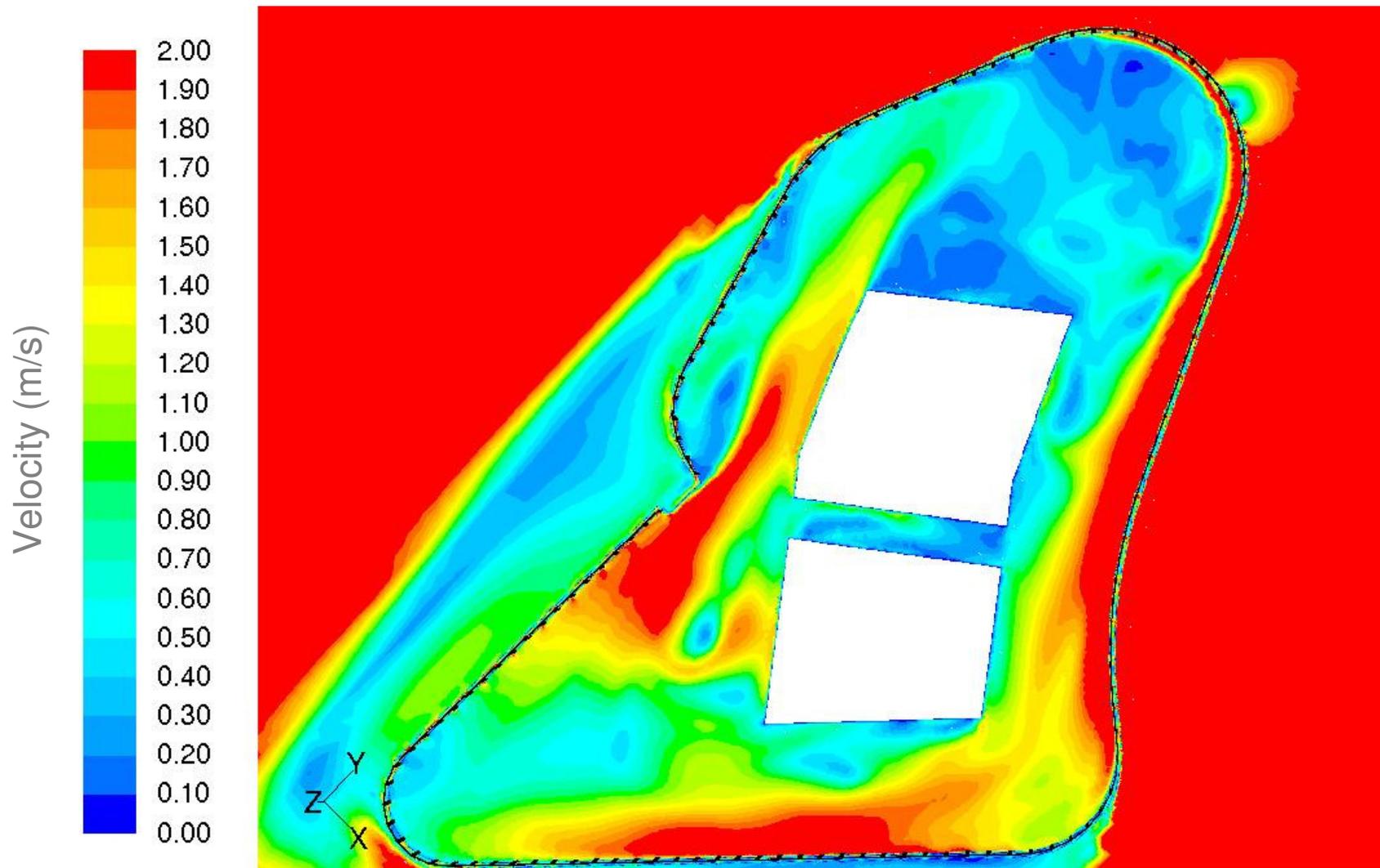
Velocity (m/s)



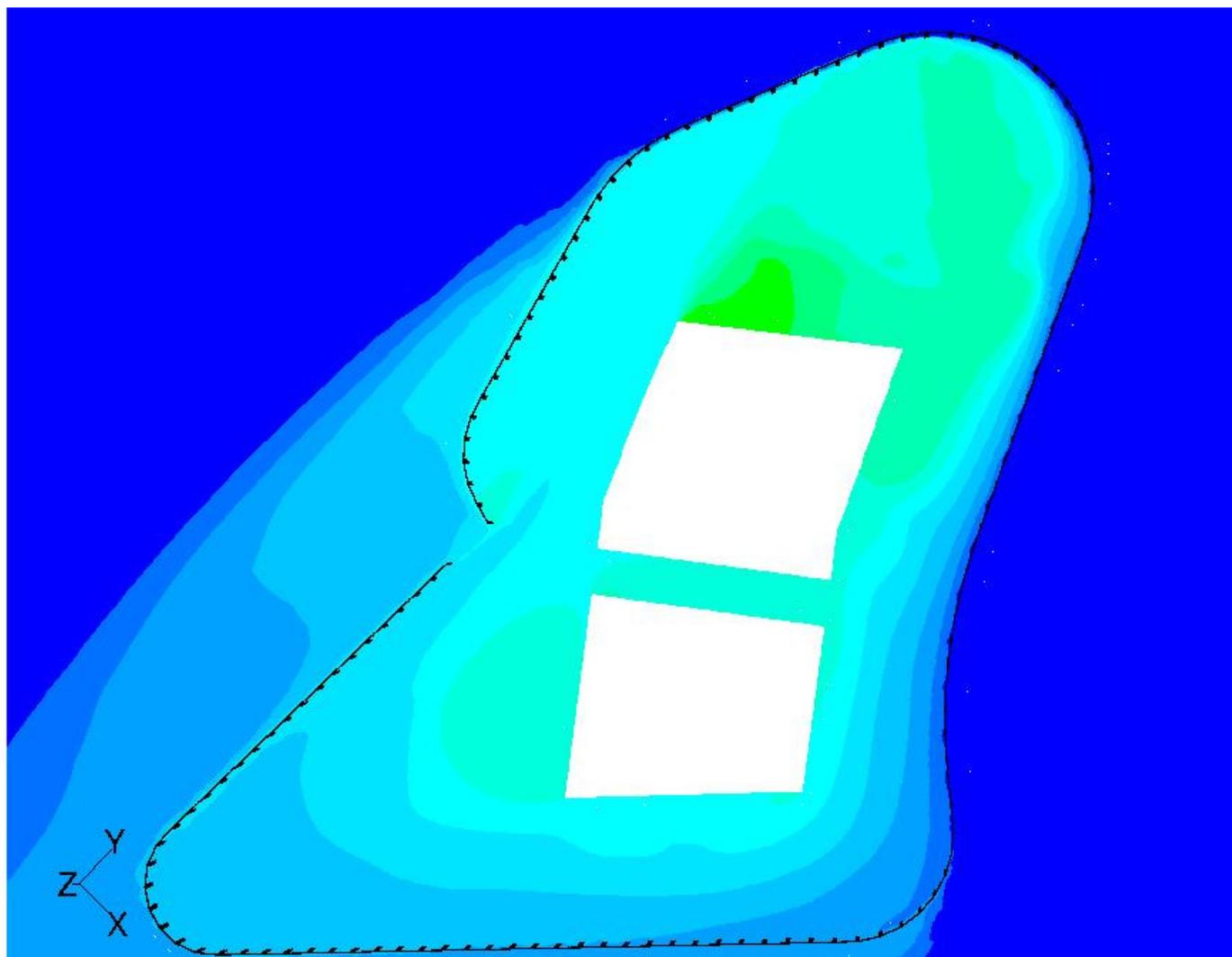
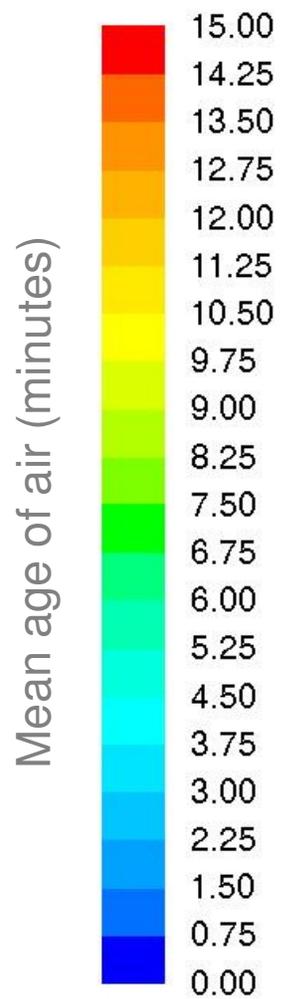
# Mixed Mode Analysis – South West Wind



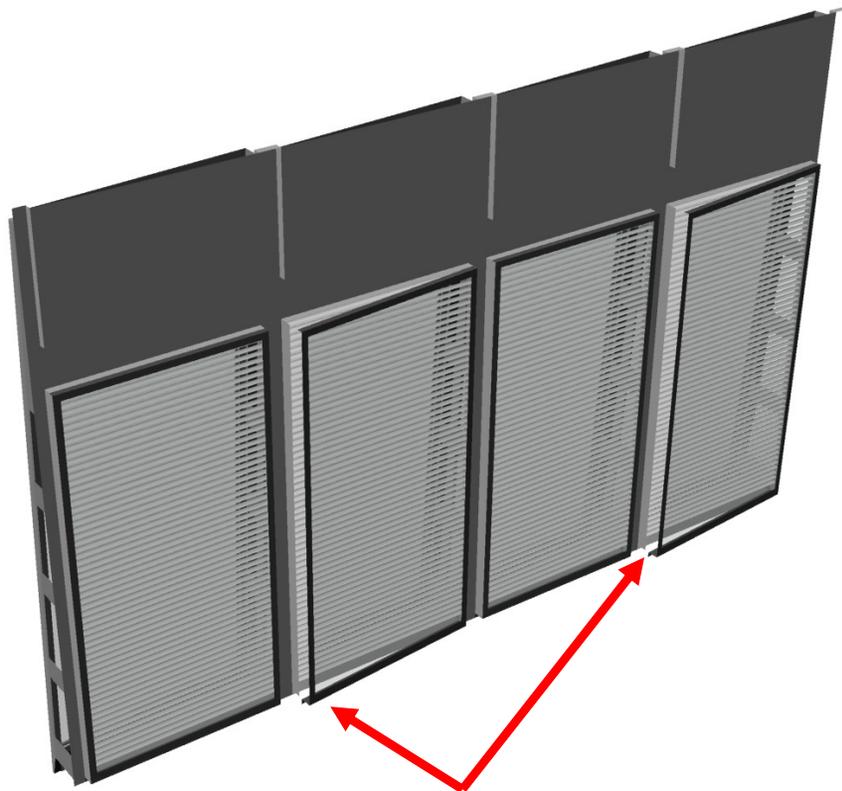
# Mixed Mode Analysis – North East Wind



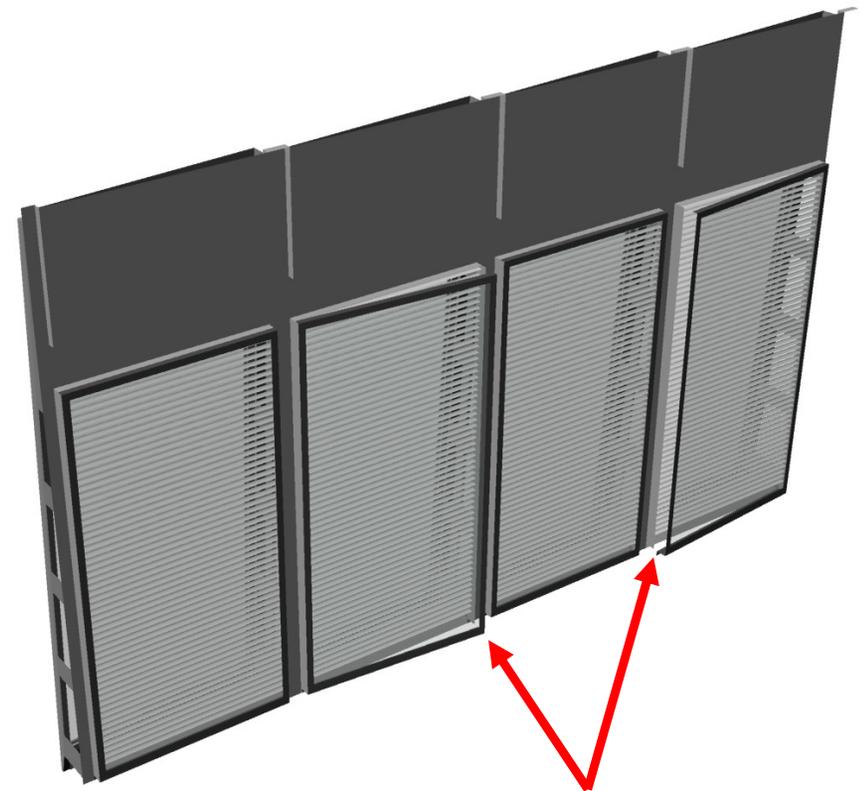
# Mixed Mode Analysis – North East Wind



# Mixed Mode Analysis



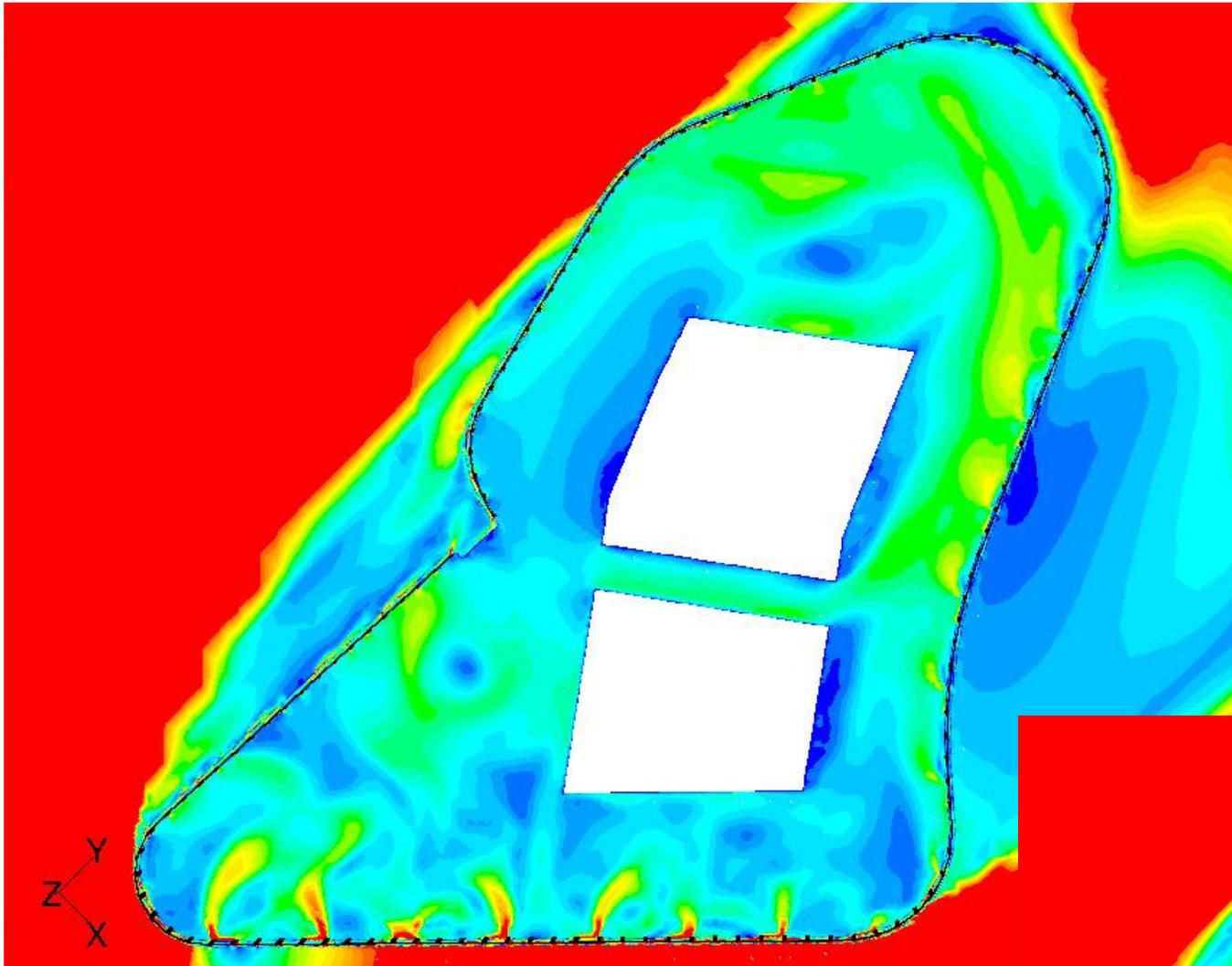
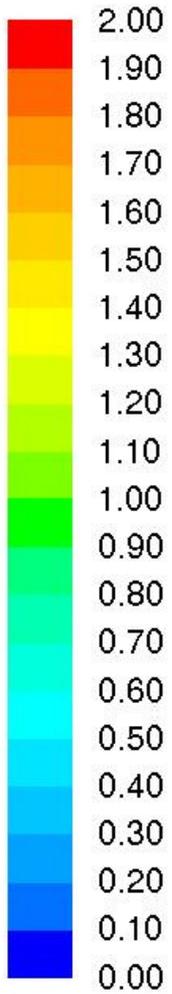
Windows open in same direction



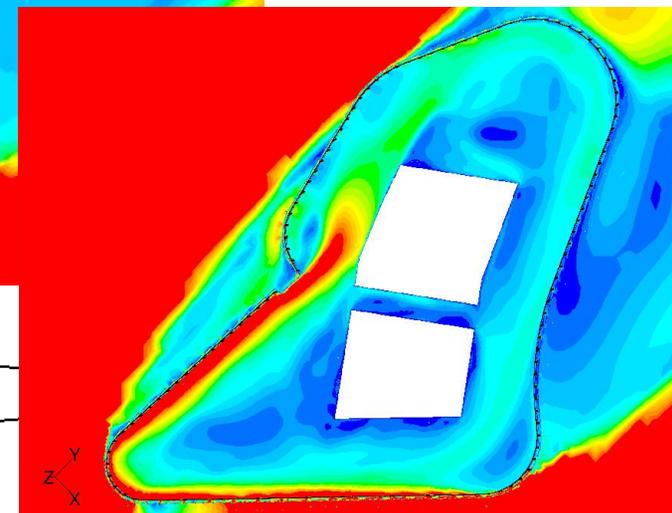
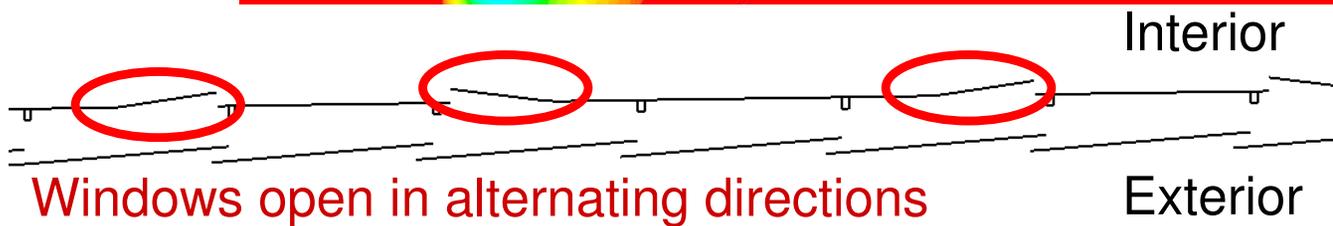
Windows open in opposite directions

# Mixed Mode Analysis – South West Wind

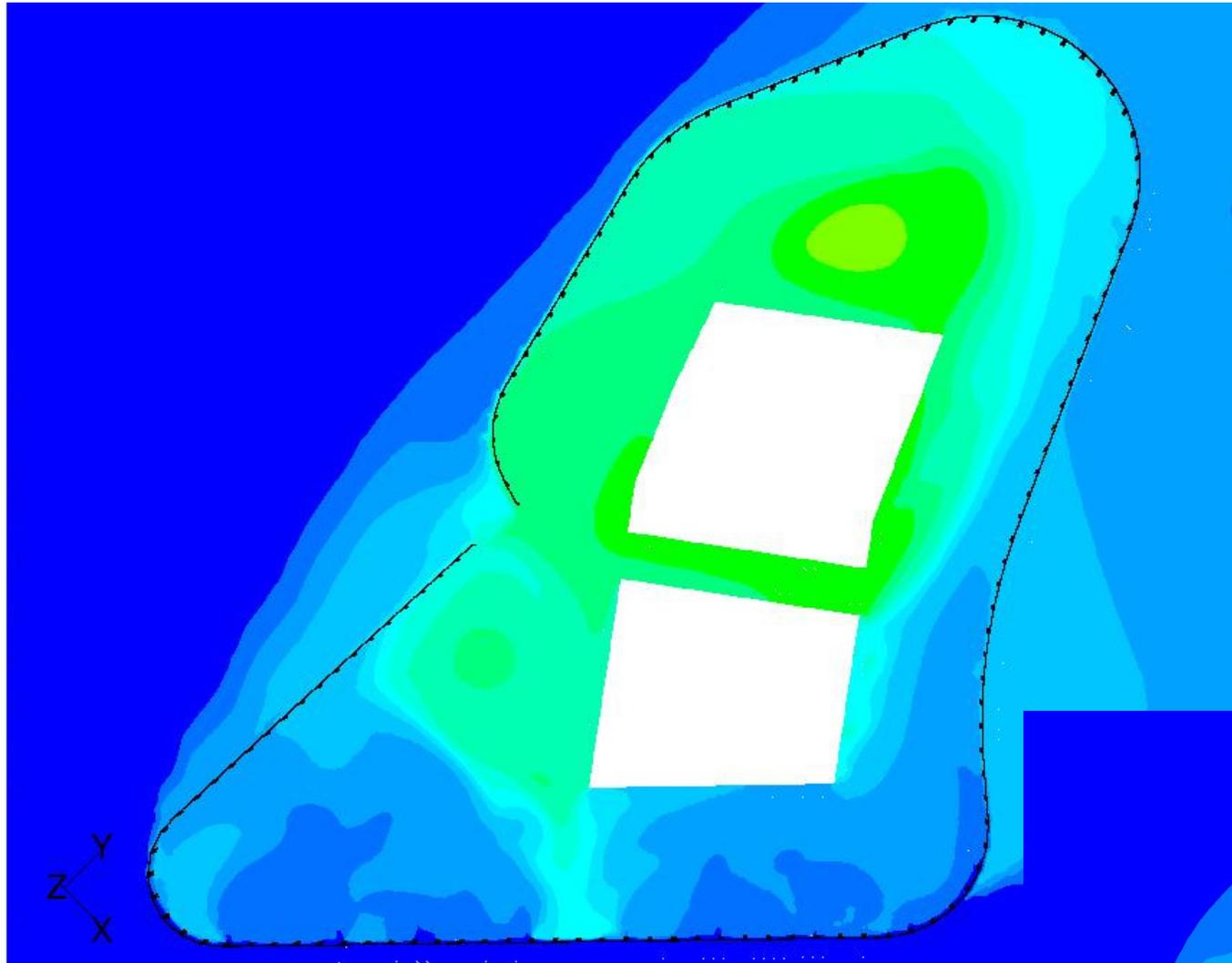
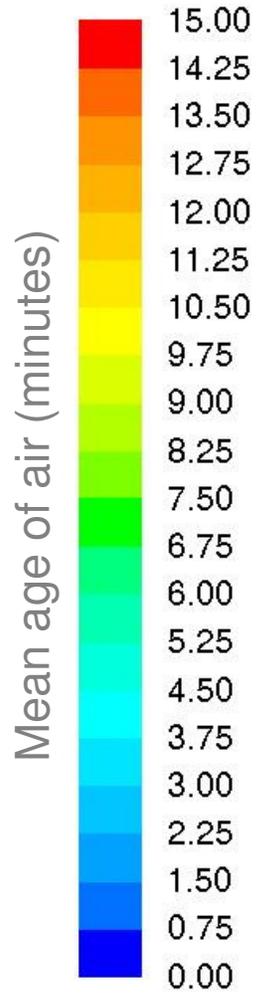
Velocity (m/s)



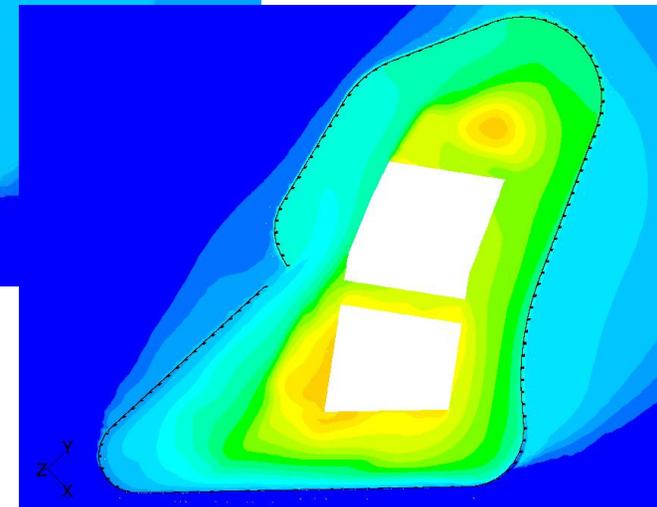
Previous model



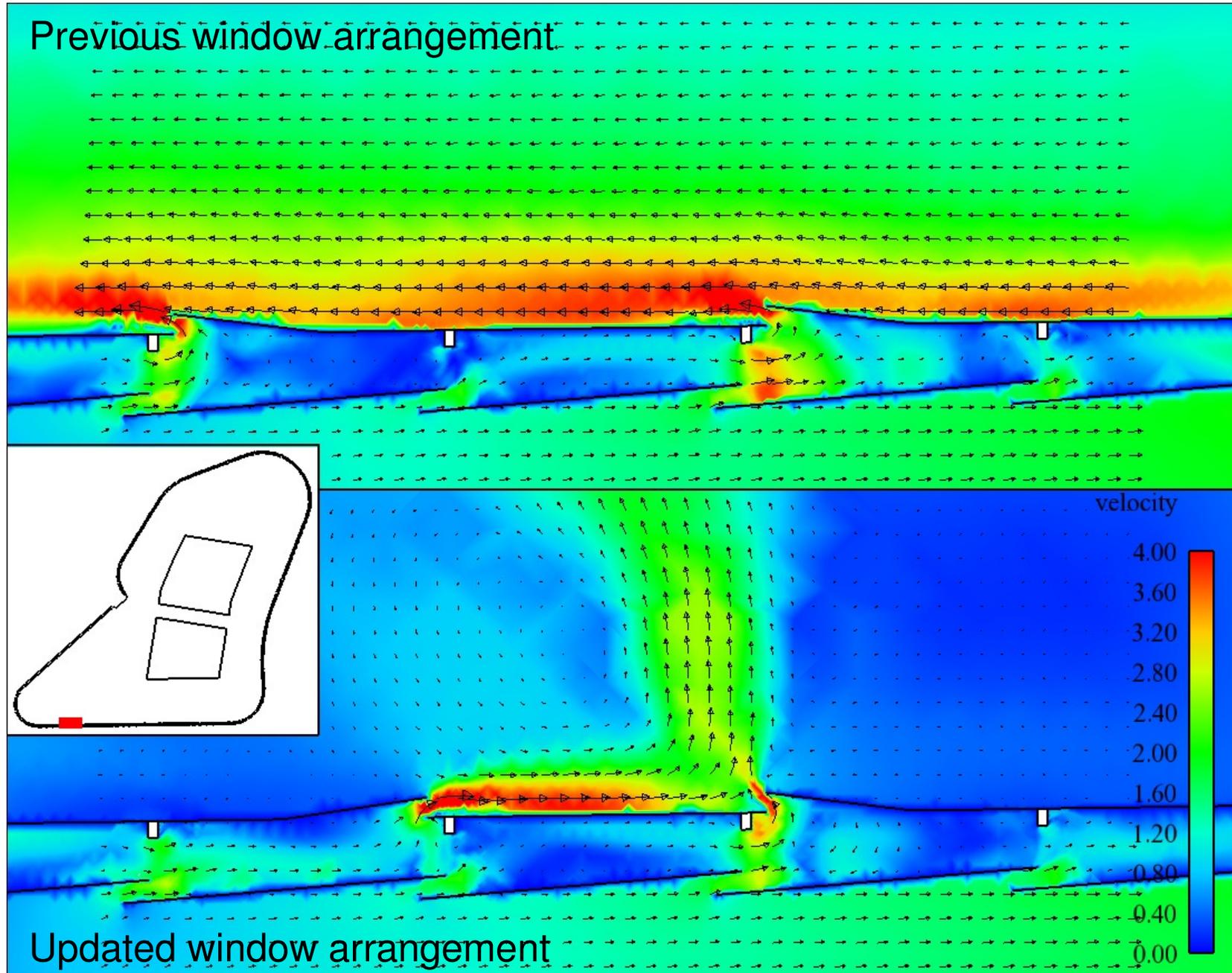
# Mixed Mode Analysis – South West Wind



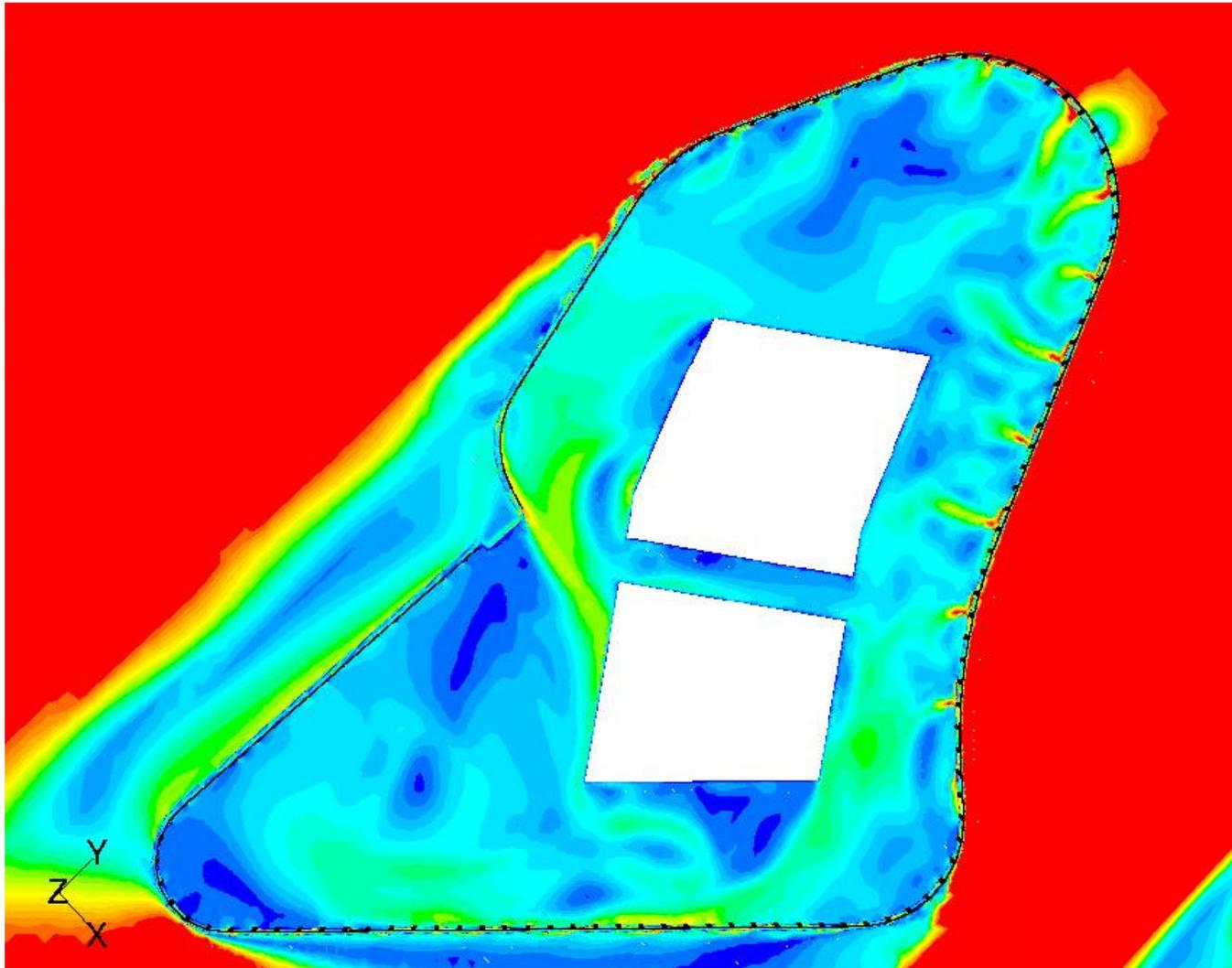
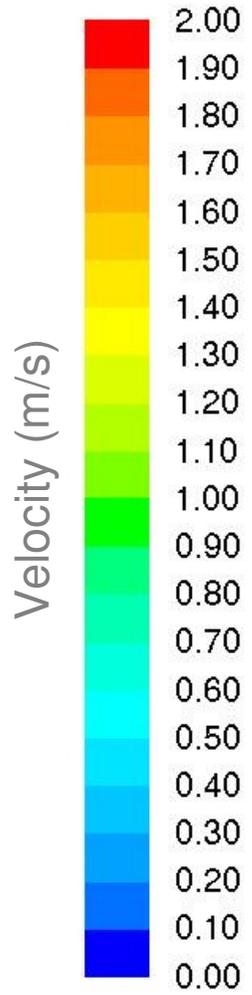
Previous model



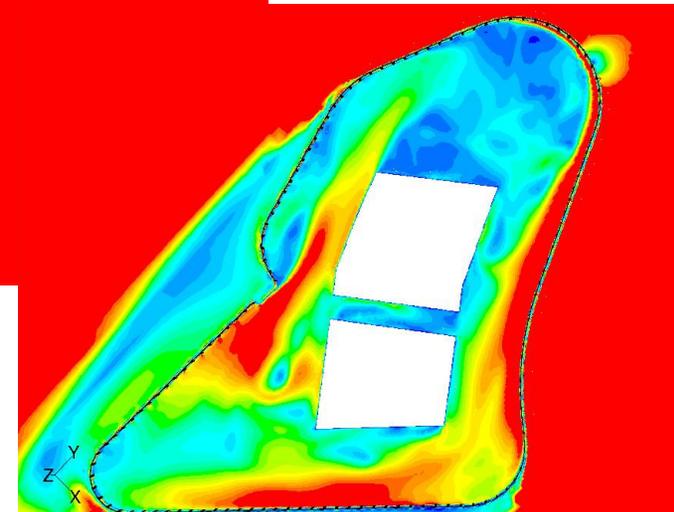
# Mixed Mode Analysis – South West Wind



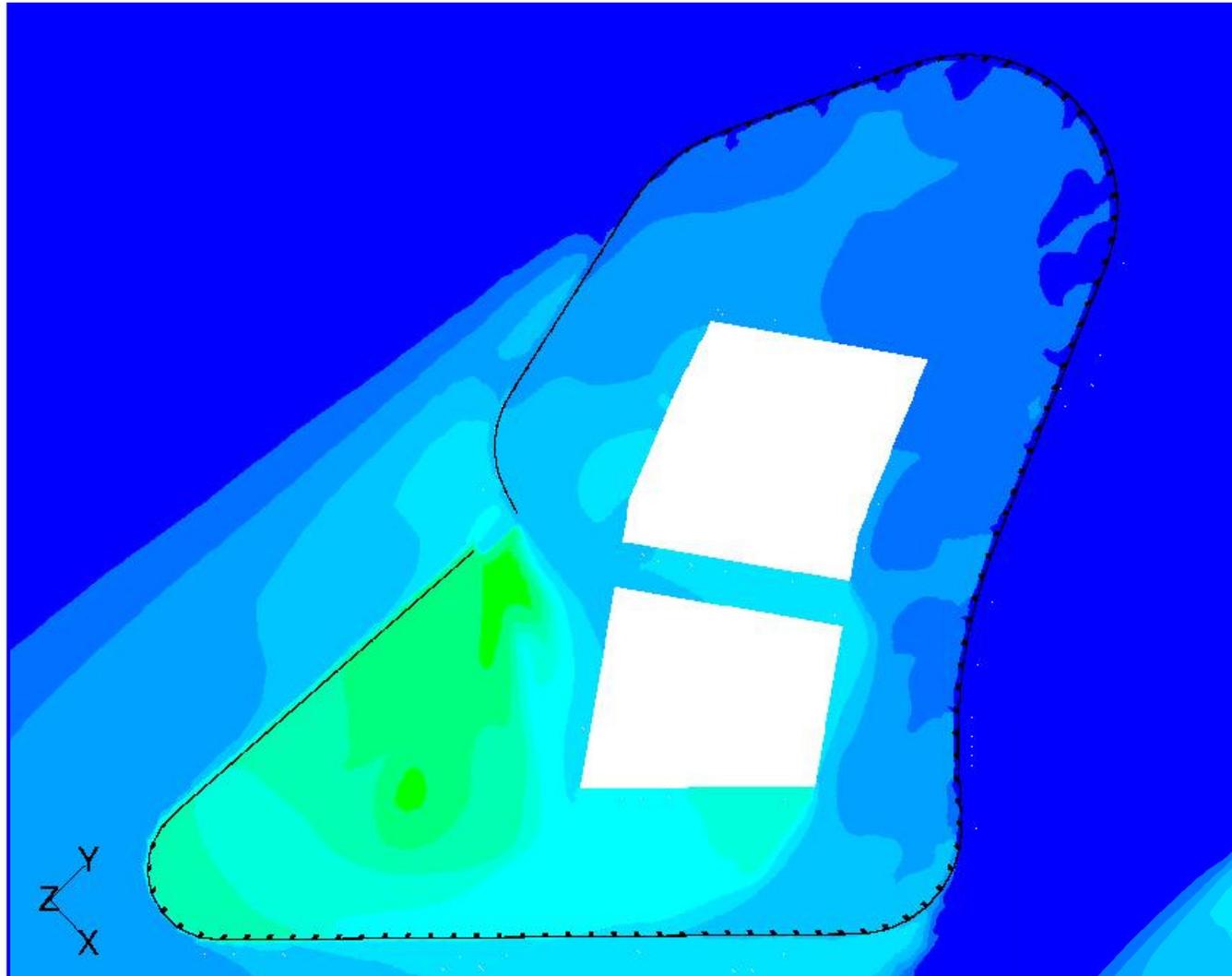
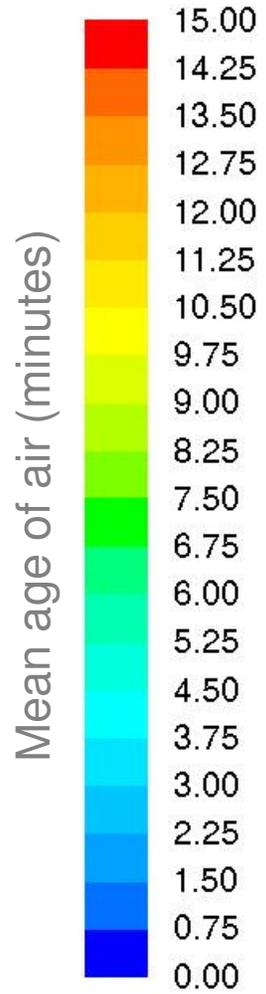
# Mixed Mode Analysis – North East Wind



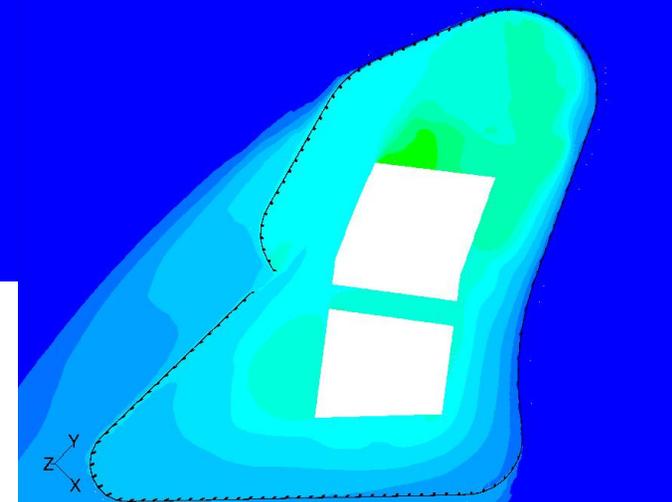
Previous model



# Mixed Mode Analysis – North East Wind



Previous model



# Conclusions

## Summary

- Thermal assessment of proposed facade design completed for worst case scenario.
- Aerodynamic assessment of proposed facade design completed for entire 41<sup>st</sup> floorplate.

## Conclusions

- Peak temperatures in the cavity are controlled by the stack effect within the space between the inner and outer elements.
- Outside air intakes should be external to the cavity.
- Inner openings should face opposing directions to prevent high velocities developing at the perimeter.
- Inner openings facing opposing directions improves the natural ventilation across the whole floorplate.
- Next steps:
  - Analyse differing floorplate shapes at different heights.
  - Test sub-divisions and partitioning arrangements.

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Questions?

