Fire Driven Flow Within Cavities Behind Perforated Cladding- CFD Investigation

Ruirui Sun, Hydrock

Liam Hamilton, Hydrock

Hydrock

Outline

- Introduction
- Fire Safety Issues for Cavities
- Perforated Cladding
- CFD modelling and Results
- Conclusion and Further Study

Hydrock

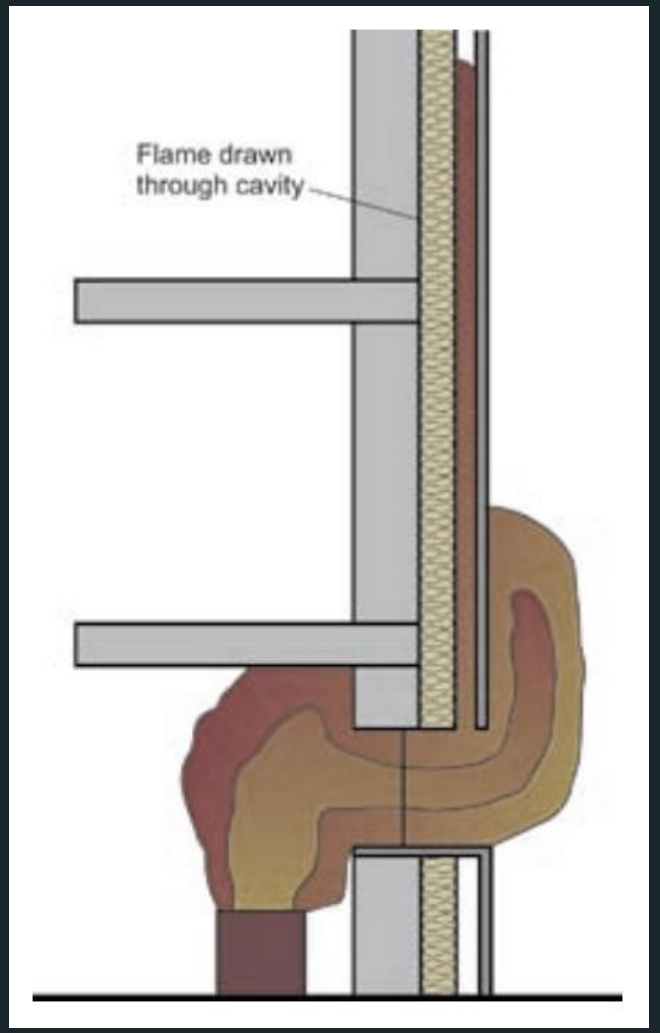
Introduction

- Tragedy Cladding Fire – Significant Life Safety Risk
- More Stringent Requirement in Updated Regulation
- Design based on the understanding the performance of the system

Hydrock

Fire Behaviour in Cavity

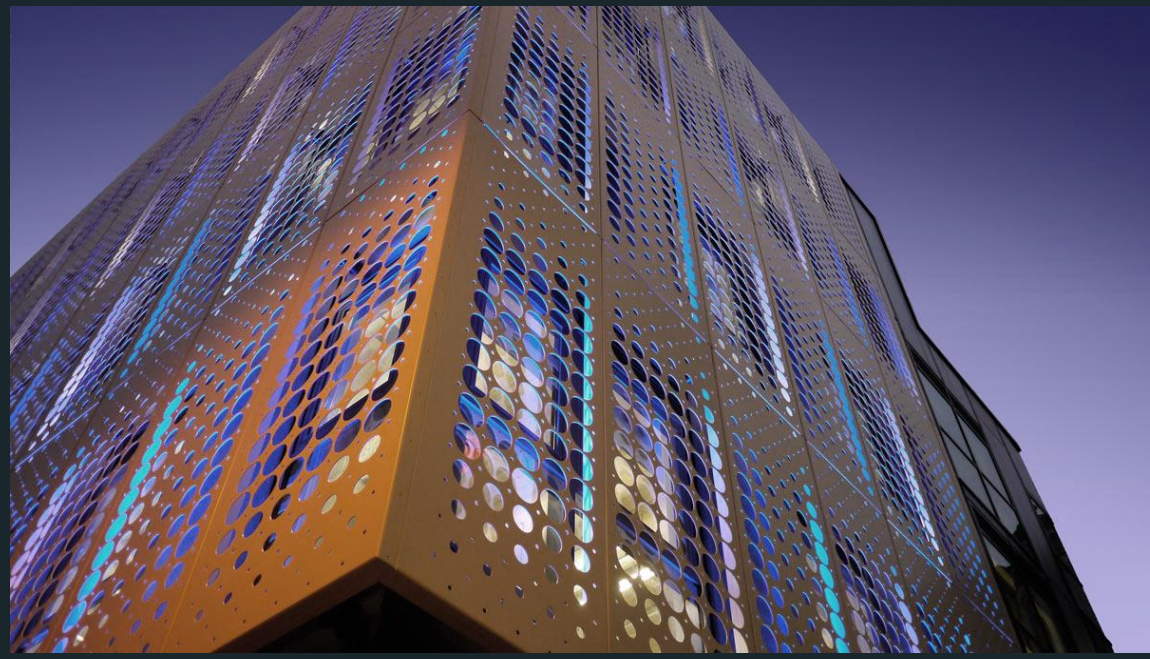
- Cladding Fire
- Cavity Space and Chimney Effect
- Flame Elongation and Spreading



Hydrock

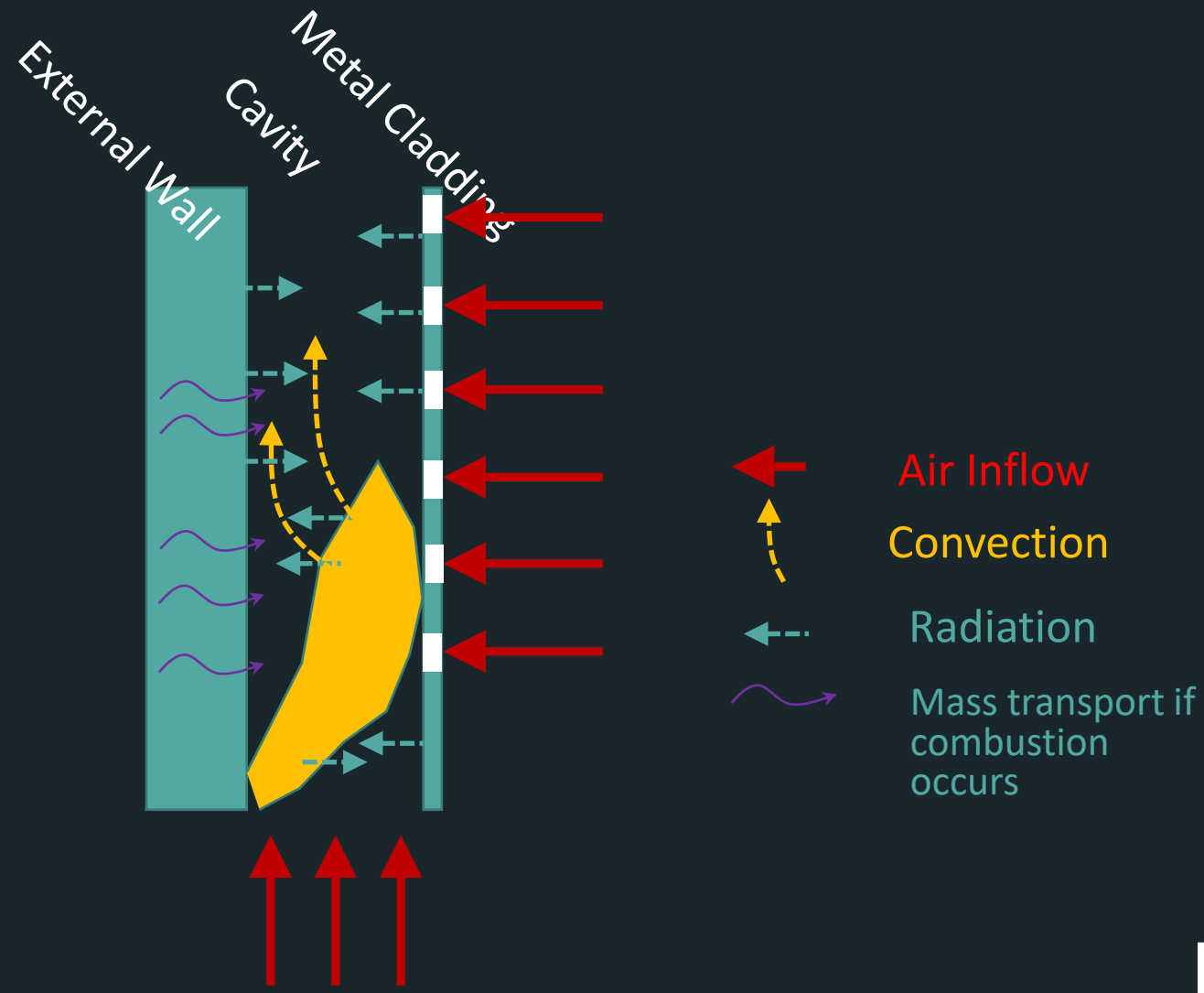
Perforated Metal Cladding

- Application of Perforated Metal Cladding
- Benefit of Cladding
- Cavity created by cladding



Hydrock

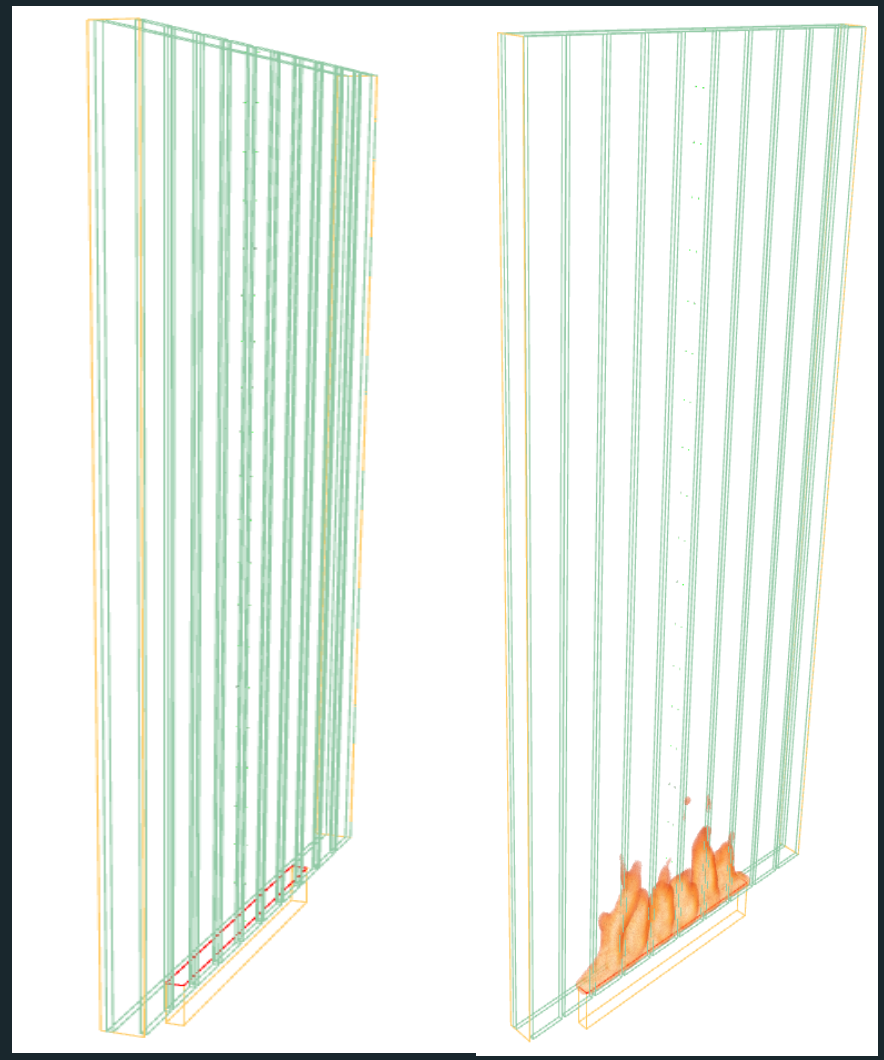
Fire Behaviour in Cavity with Perforation



Hydrock

CFD Modelling

- Brickwork and Metal Cladding
- Burner Fire
- Parameters:
  - Cavity Depth: 40mm, 80mm and 120mm
  - Perforated Ratio of Metal Cladding: 0%, 10%, 25%, 50%
  - Intensity of Fire: 15 kW/m, 30 kW/m and 150 kW/m
- Limitation
  - Perforation Shape, size
  - Realistic Fire within compartment
  - External Wall Construction



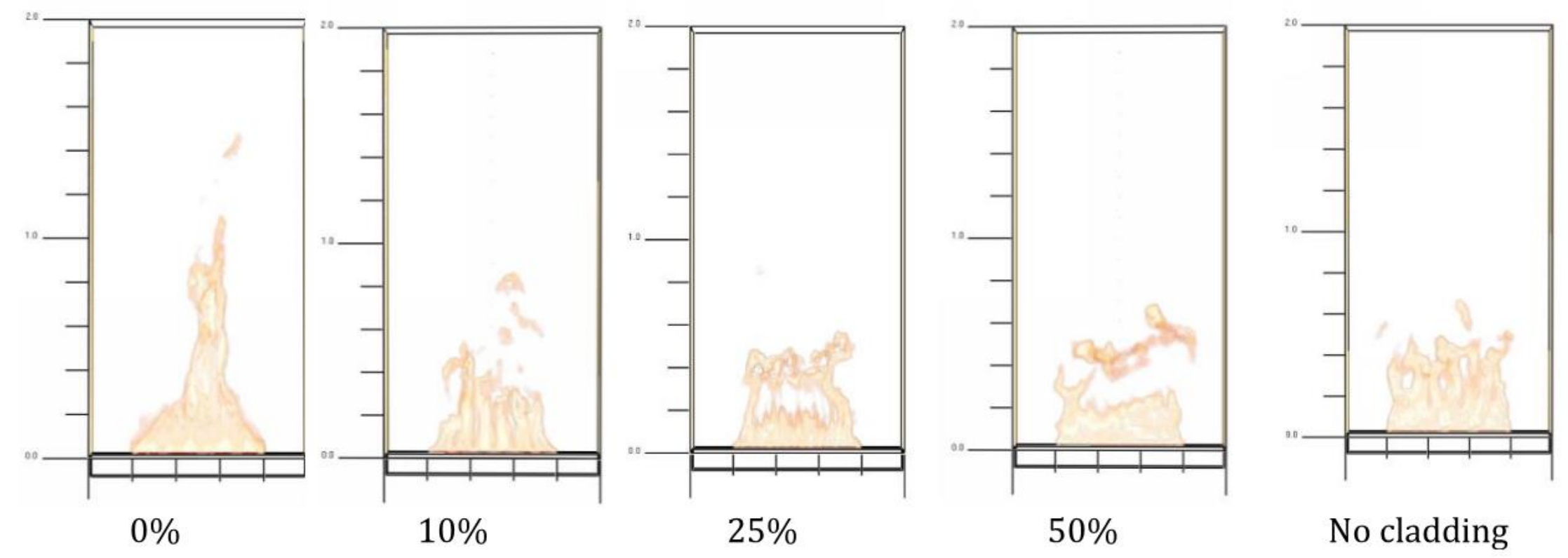
Hydrock

Mesh Sensitivities

	5mm	10mm	20mm
Average Temperature at 0.2m above fire (°C) Deviation	690 -	760 **10%**	491 28%
Average Temperature at 0.6m above fire(°C) Deviation	467 -	497 **6%**	324 29%
Average Temperature at 0.8m above fire(°C) Deviation	402 -	430 **7.5%**	278 31%
Average Velocity at 0.2m above fire(m/s) Deviation	2.1 -	2.2 **5%**	2.7 28%
Average Velocity at 0.6m above fire(m/s) Deviation	2.0 -	2.1 **5%**	2.7 35%
Average Velocity at 0.8m above fire(m/s) Deviation	2.0 -	2.1 **5%**	2.6 30%
Average Incident HF at 0.2m above fire(kW/m^2) Deviation	18.7 -	16.2 **13%**	11.9 36%
Average Incident HF at 0.6m above fire(kW/m^2) Deviation	5.1 -	5.2 **3%**	2.7 46%
Average Incident HF at 0.8m above fire(kW/m^2) Deviation	3.7 -	3.9 **5.3%**	2.34 36%

Hydrock

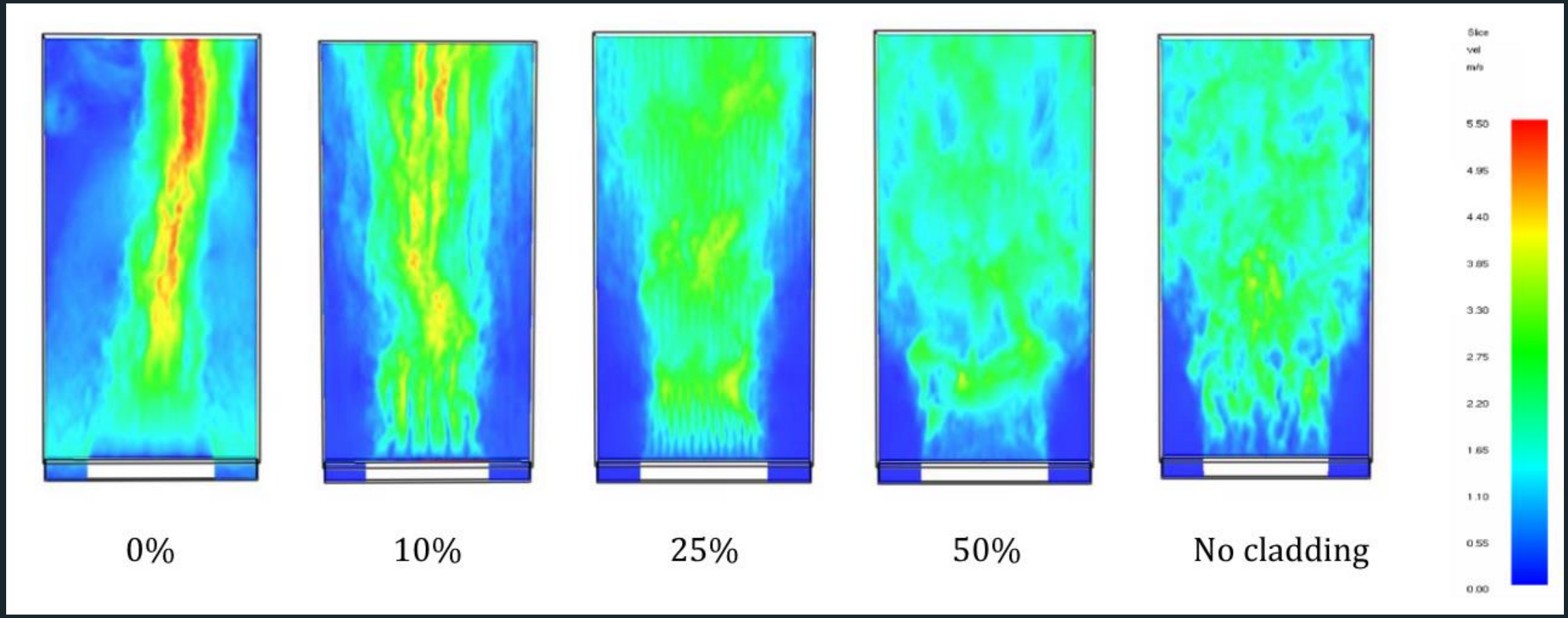
CFD Results - Impact of Perforation Ratio



Flame Height

Hydrock

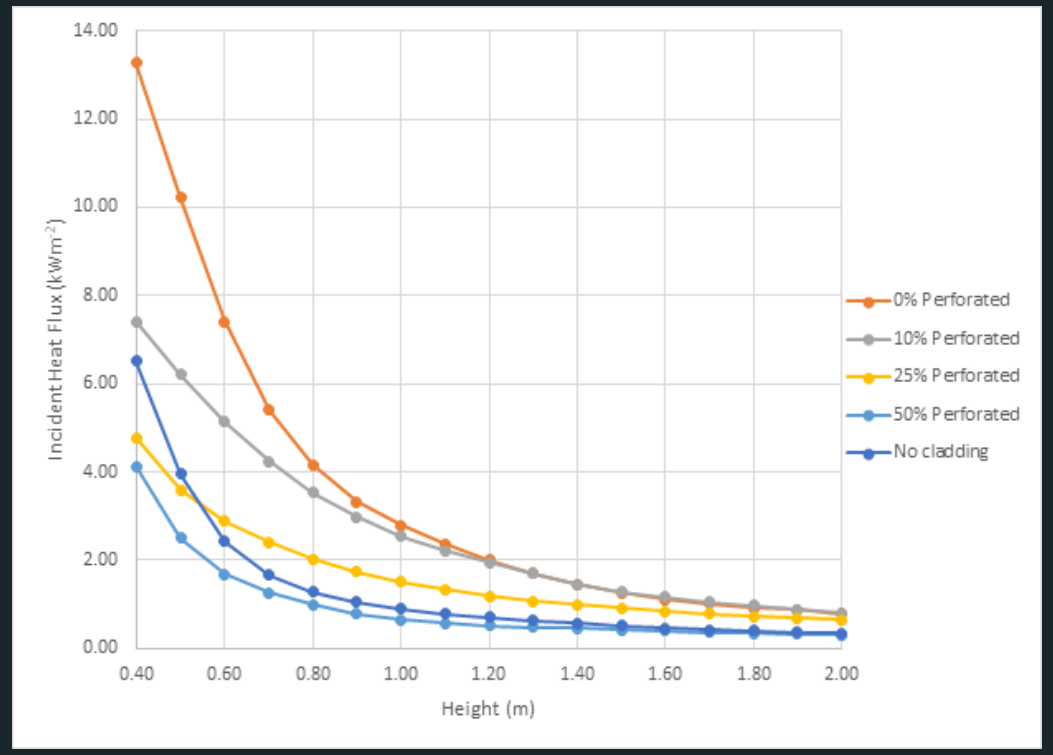
CFD Results - Impact of Perforation Ratio



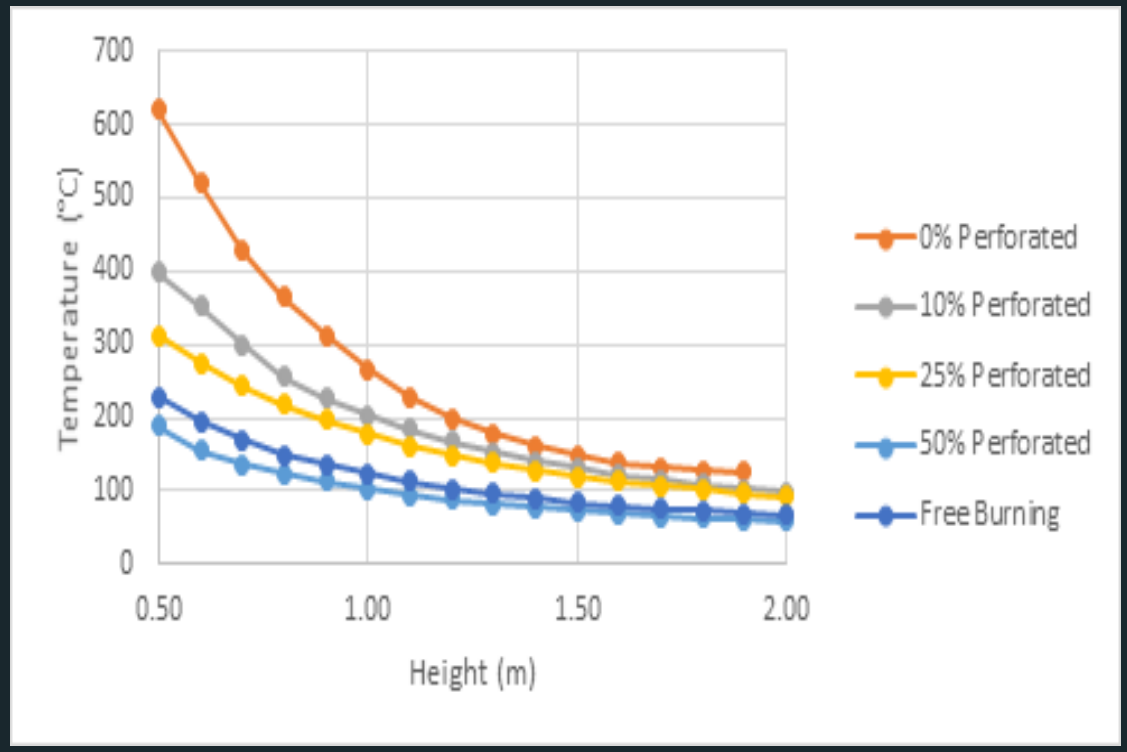
Velocity

Hydrock

CFD Results - Impact of Perforation Ratio



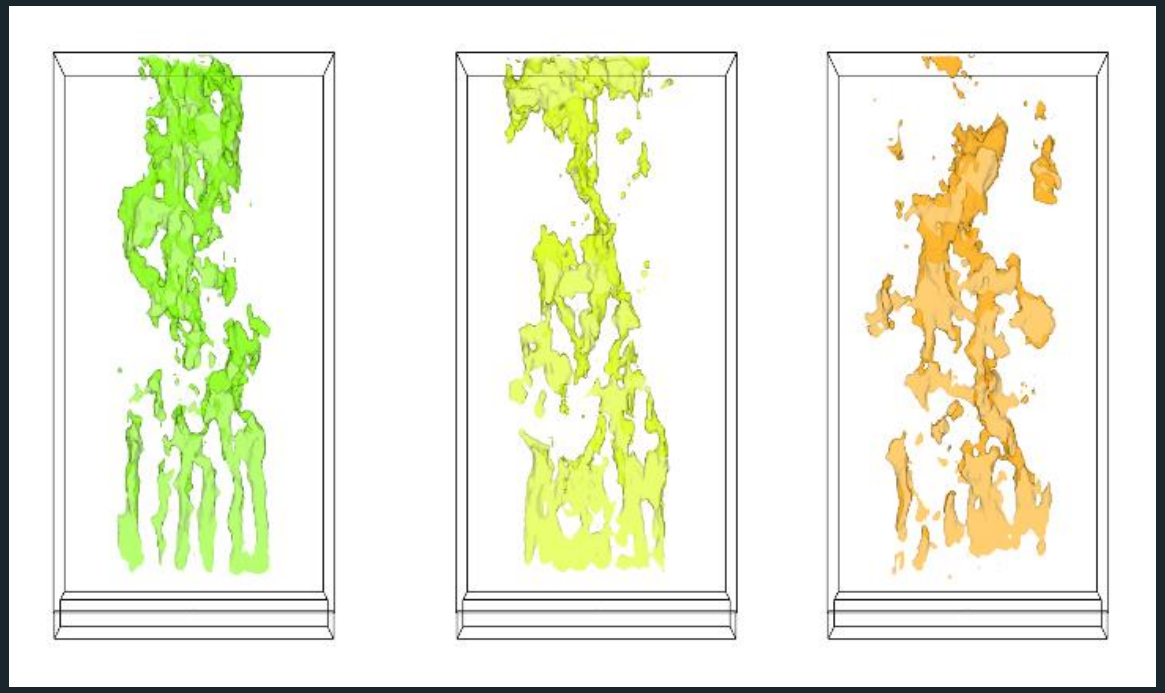
Incident Heat Flux



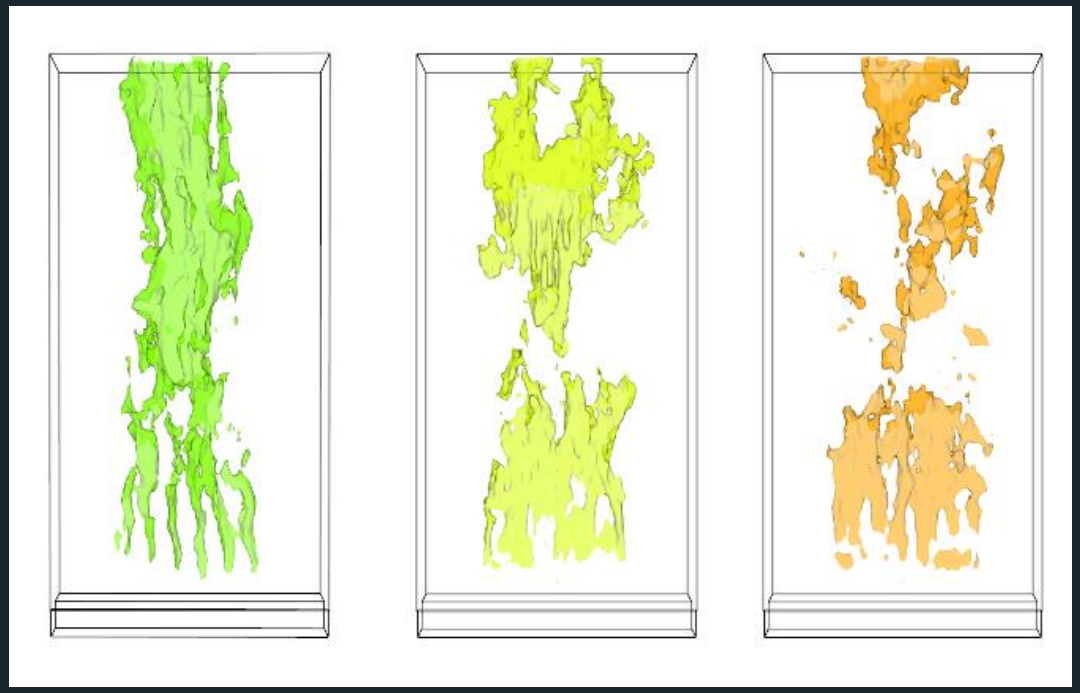
Temperature

Hydrock

CFD Results - Impact of Cavity Depth



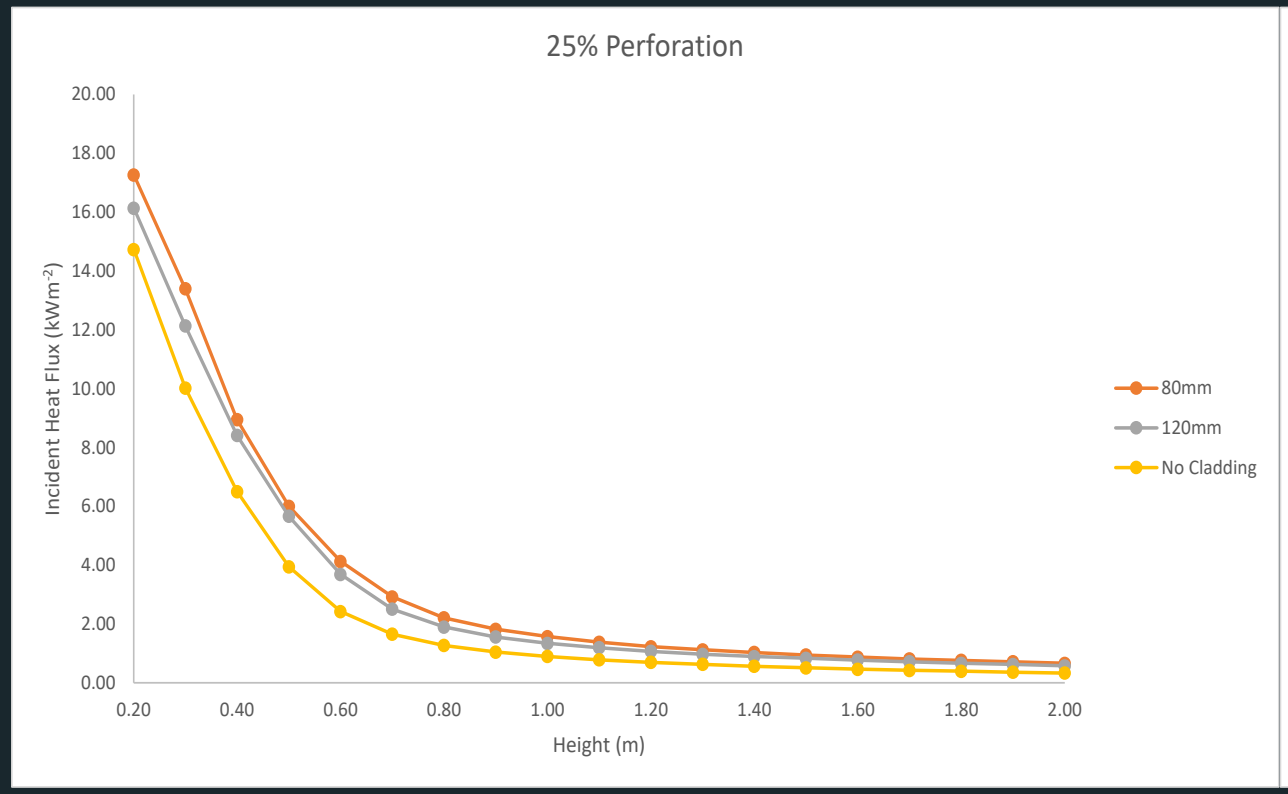
Velocity (120mm (10%, 25%, 50% perforation))

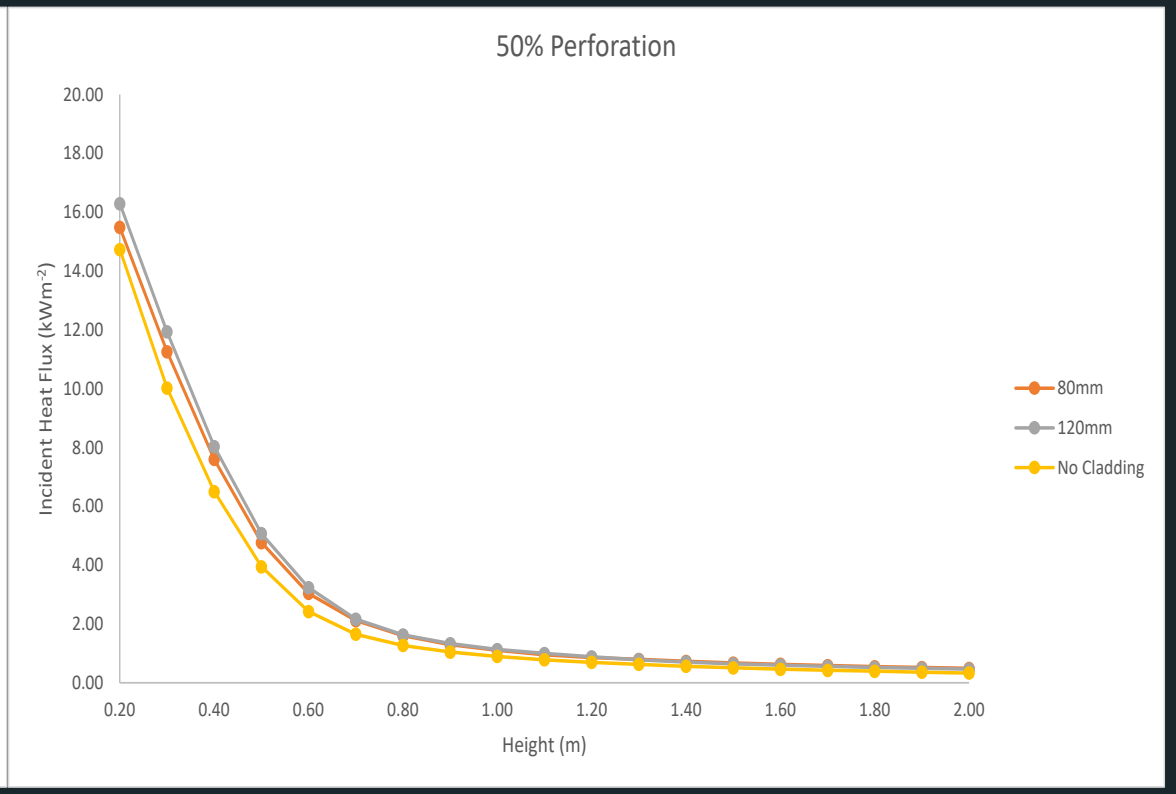


Velocity (80mm (10%, 25%, 50% perforation))

Hydrock

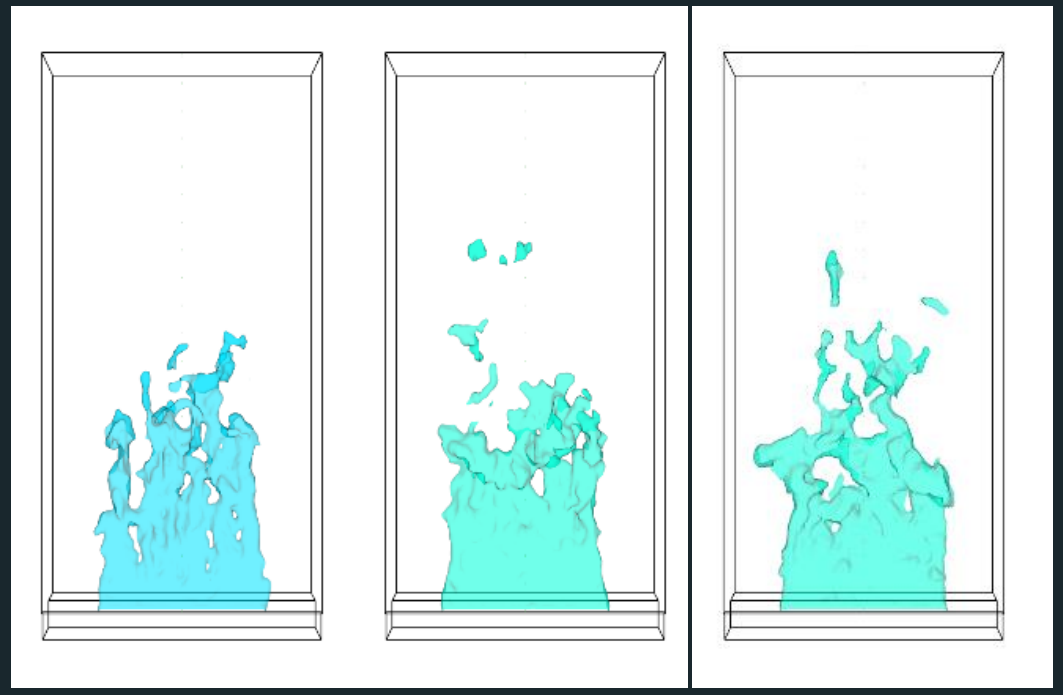
CFD Results - Impact of Cavity Depth



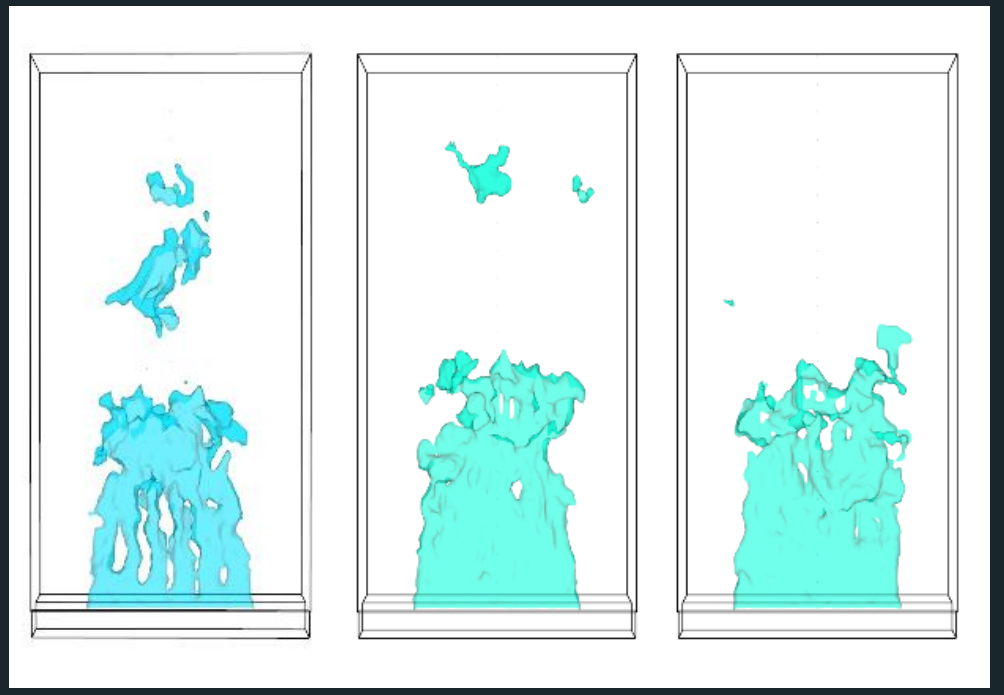


Hydrock

CFD Results - Impact of Cavity Depth



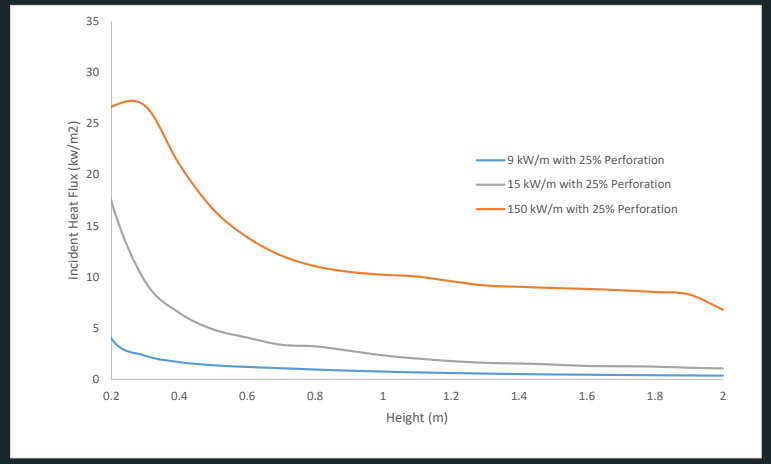
Temperature (120mm (10%, 25%, 50% perforation))



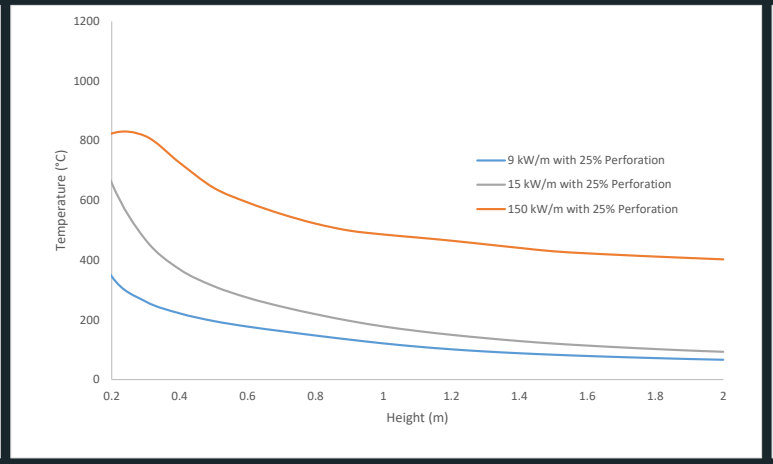
Temperature (80mm (10%, 25%, 50% perforation))

Hydrock

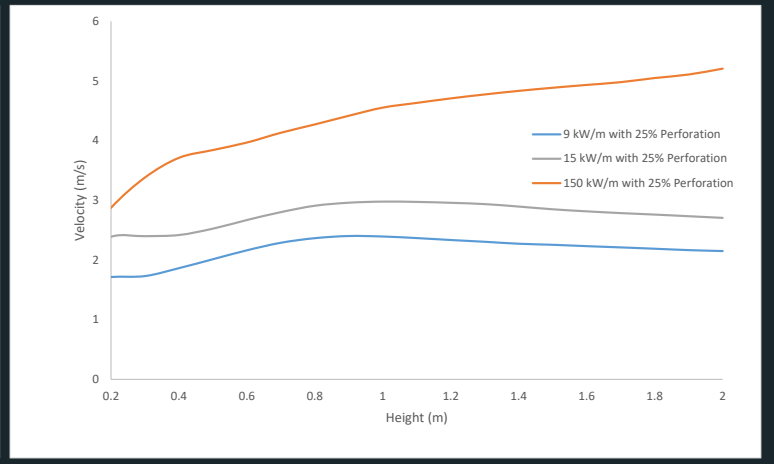
CFD Results - Impact of Fire Size



Incident Heat Flux



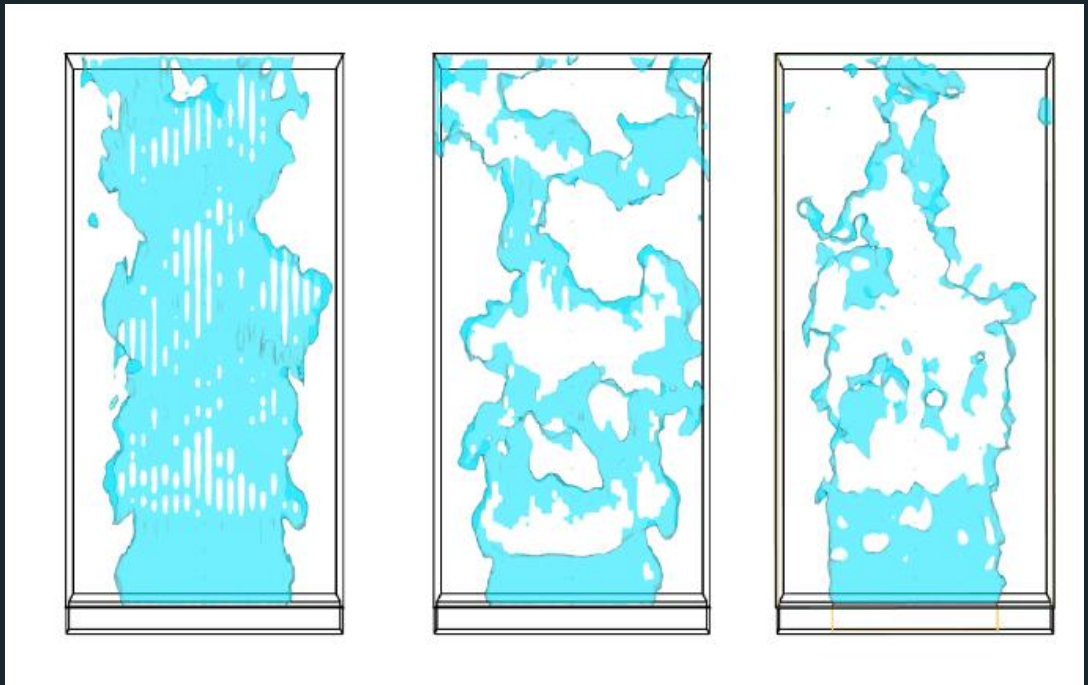
Temperature



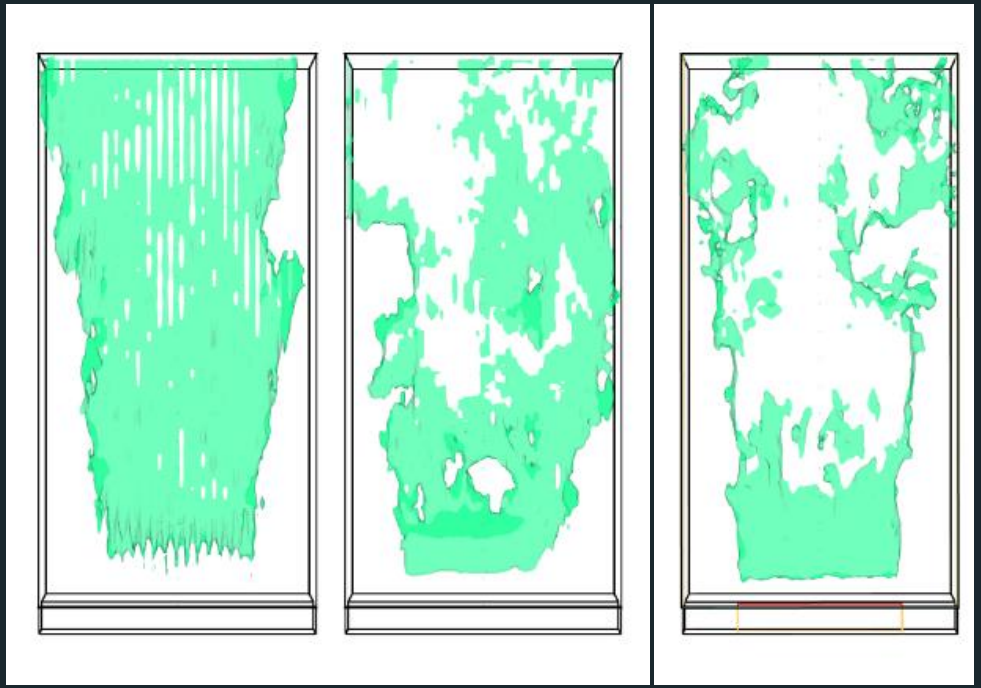
Velocity

Hydrock

CFD Results - Impact of Fire Size



200°C Isosurface Temperature (150kW/m (25%, 50% 100%perforation))



2.0m/s Isosurface Velocity (150kW/m (25%, 50% 100%perforation))

Hydrock

Further Study

- Post Flashover with Real Cladding System
- Perforation Shapes
- Experimental Study

Hydrock

Conclusion

- Perforation ratios has significant influence on the fire drive air flow within the space.
- Flame height is reduced significantly due to the perforation on the cladding
- With the perforation ratio of more 50%, the Velocity, Incident HF and Temperature of the fire driven flow within the cavity is very similar with the case with no cladding;
- Shallower cavity generally induces higher flame height and higher upward air flow with the cavity. However, if the cavity depth is over 80mm and the perforation is over 50%, flame height, the incident heat flux and temperature within the cavity are very similar;
- With the fire intensity increasing, the temperature, velocity and incident heat flux within the gap increases.

Hydrock

Thank You!

Hydrock