DRDL
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A study on the approach to reduce wind effects through porous wall configuration for indoor pool fire tests

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Background

- Fire testing fire suppression products – carried out globally indoors and outdoors
- Outdoor testing – susceptible to ambient winds – Test protocols limit winds to < 2 m/s
- Typically Indoor configurations are mechanically ventilated – difficult, leads to excruciating conditions indoors - fire behaviors different from outdoors
- Experiments to provide a design basis for porous wall structure & computations of the indoor flow field will be presented

Fire Test Facility UL North Brook, USA

UL standards Fire Test Facility -18 x 12 x 6.6 m high

Mechanical Ventilation – Moving away dirt hot gases at the top; if inadequate, will fill the room & smoke descends causing operational problems, huge blowers needed

Total 12 m^3/s Air supplied to 4 corners

Total blower power estimated – 250 kWe

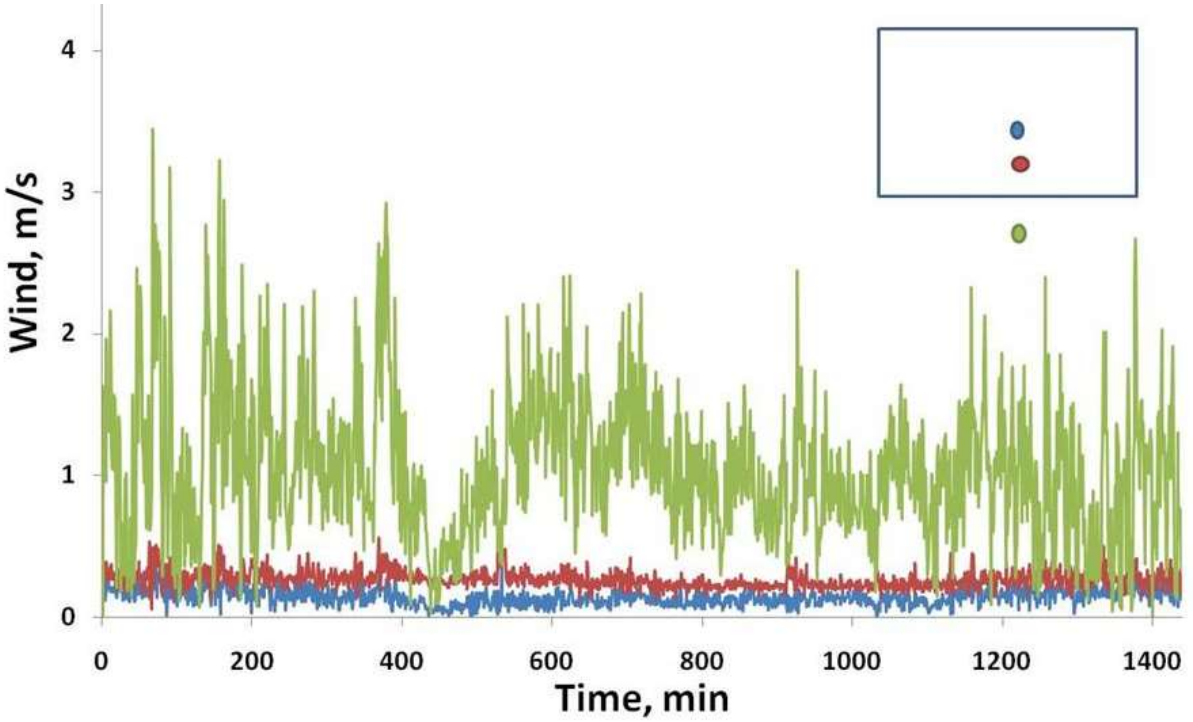
Jain Fire Lab

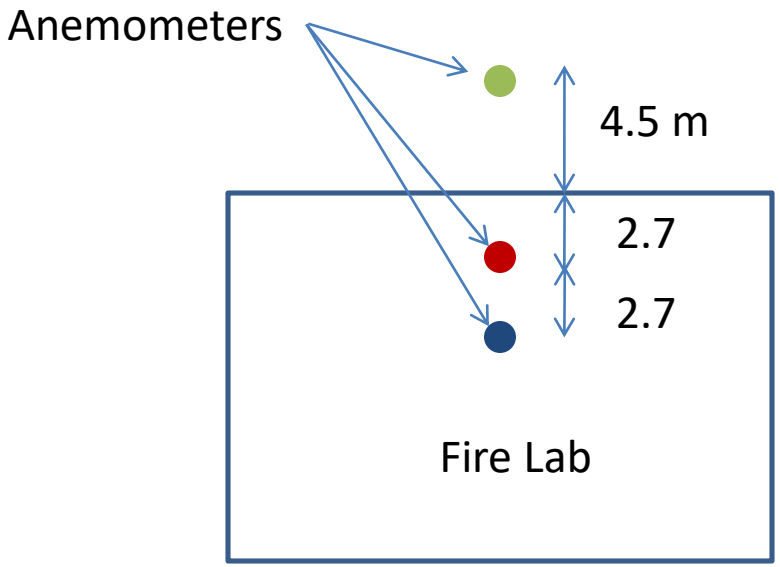
- Built with double staggered porous wall structure
- Indoor fire tests carried out by UL have met with standard requirements for indoor conditions for large fire tests

20 B test

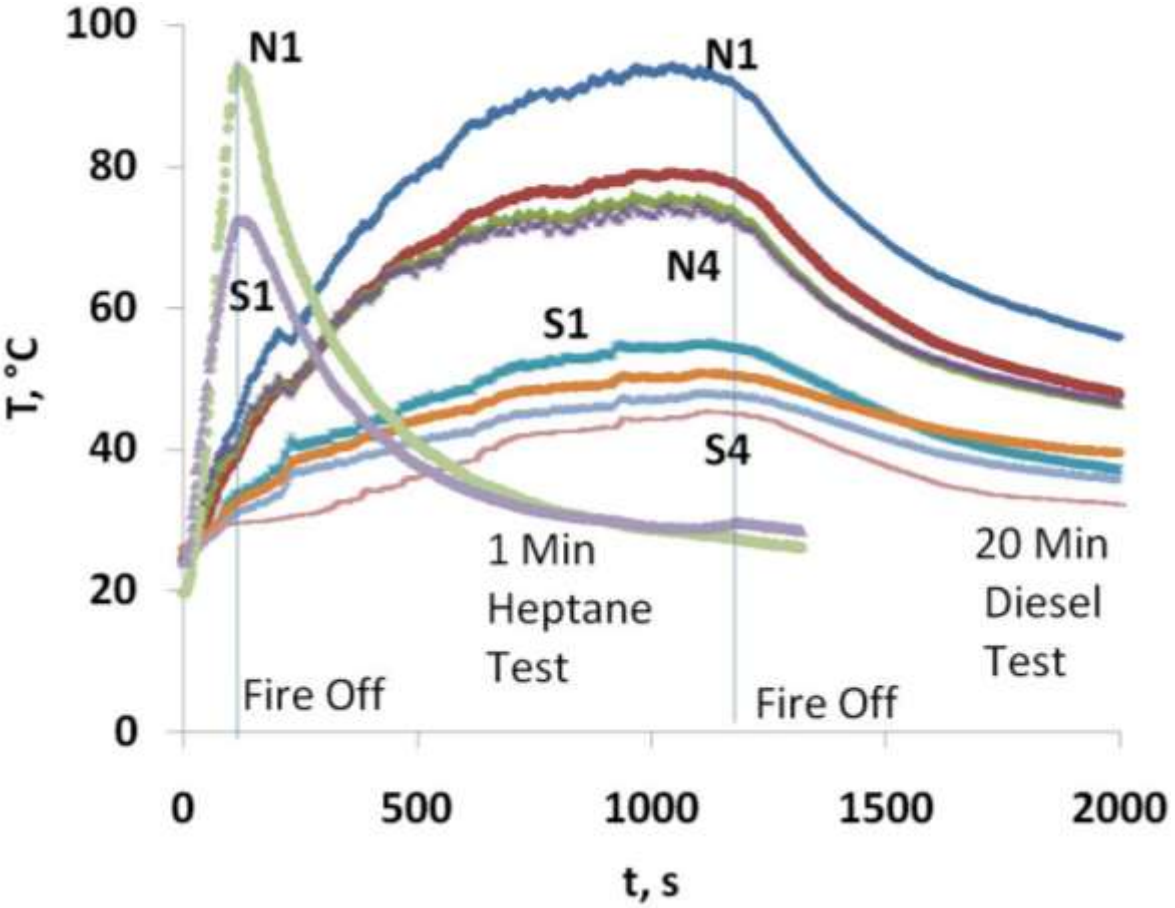
Jain Fire Lab

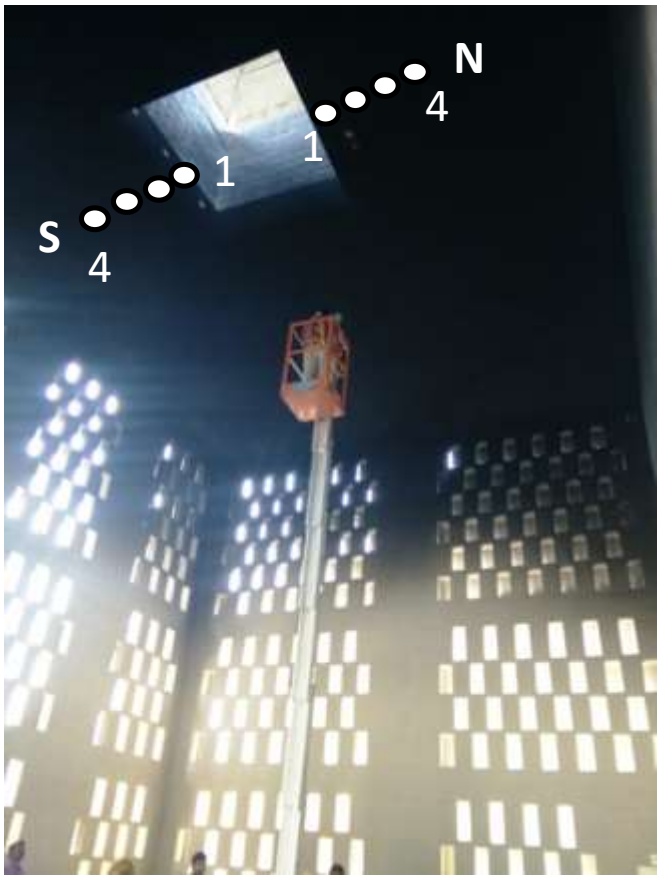
- Simultaneous measurements of wind inside & outside fire lab
- It is seen that indoor velocities are very low and the environment inside qualifies to be 'indoor' condition





Indoor Fire Lab Roof T Data





- A 20 min diesel pool fire was run to evaluate performance
- Min smoke emitting height was seen to be 7 m
- Roof wall temperature attained is acceptable to the design

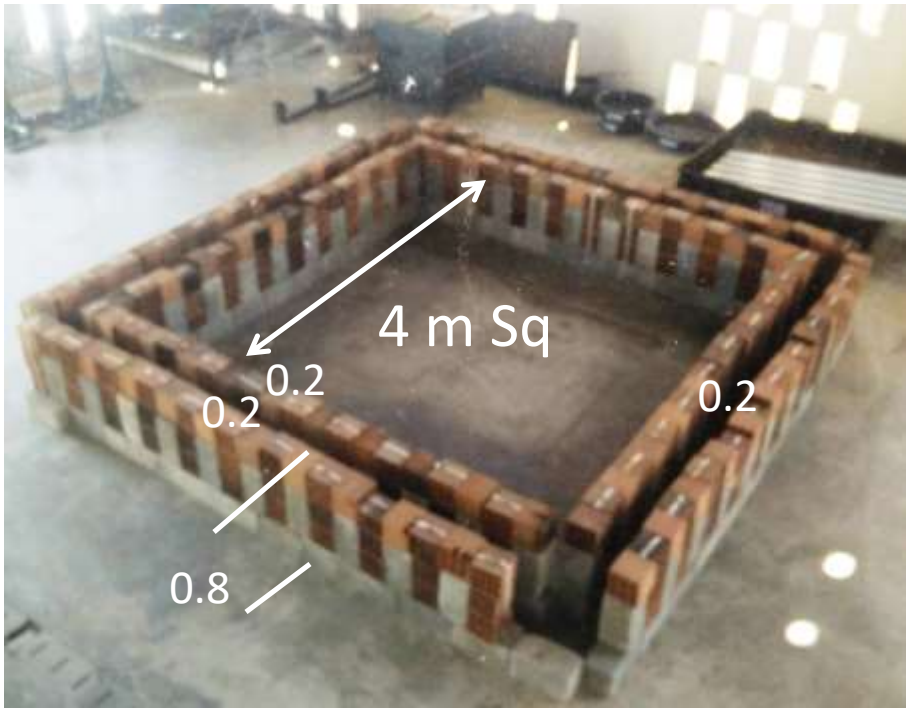
Fire Tests with Small Pans

- Existing porous wall configuration adequate for large pool fires
- Smaller pan fires were found to be susceptible low ambient disturbances
- Bottom 3 layers of Fire lab closed as shown
- This has resulted in undisturbed small pan fires

Porous Restriction
in Bottom Region

Small Pool Experiments

- A double walled porous 4 m Sq x 0.8 m high - created at the center of the fire lab with annular gap of 0.2 m
- Indoor conditions monitored using anemometers with steady wind of about 2 m/s provided using a Pedestal fan
- 500 mm dia pan fire tested in this configuration



Small Pool-Experiments

- Cold flow measurements with 2 m/s wind generated by fan shown
- Measurements indicate inside velocities < 0.3 m/s

Small pools - Experiments

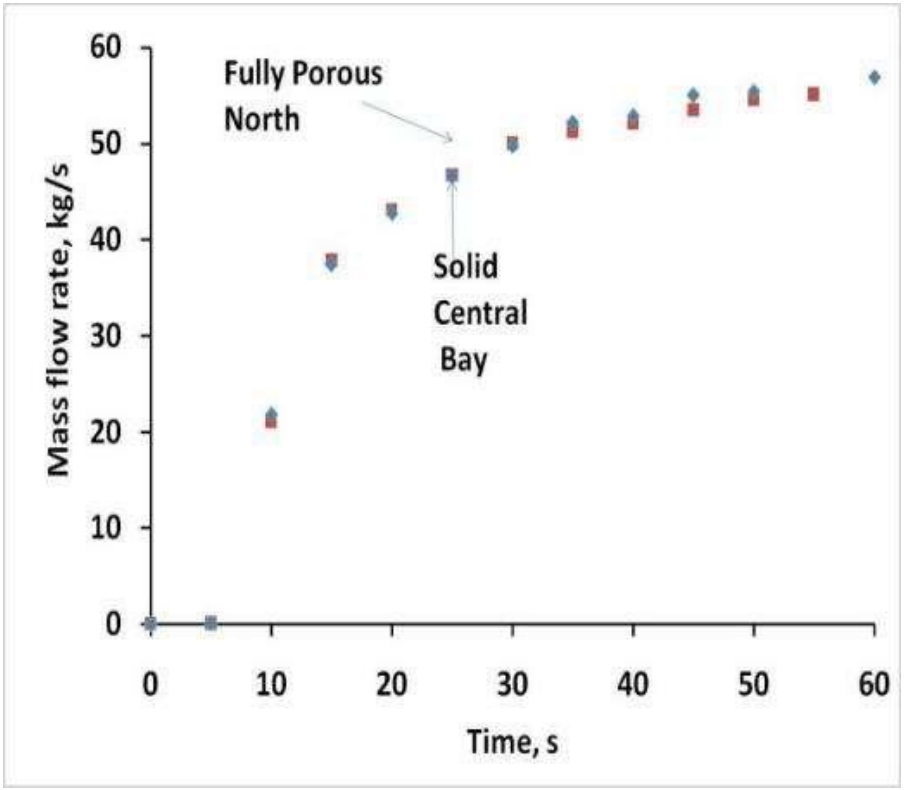
Still ambient

2 m/s (Fan Velocity)

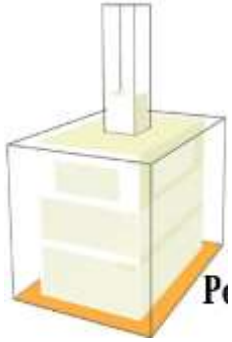
Work is in progress to carry out experiments with Different levels of porosity for smaller pool sizes to eliminate random wind effects

FDS – Porous Wall Facility

- FDS used as a tool during Jain fire lab development
- Initially effect of solid North was computed to quantify its influence
- Studies have indicated marginal increase in flow rates
- Fire behaviour was also compared with literature results as shown next..

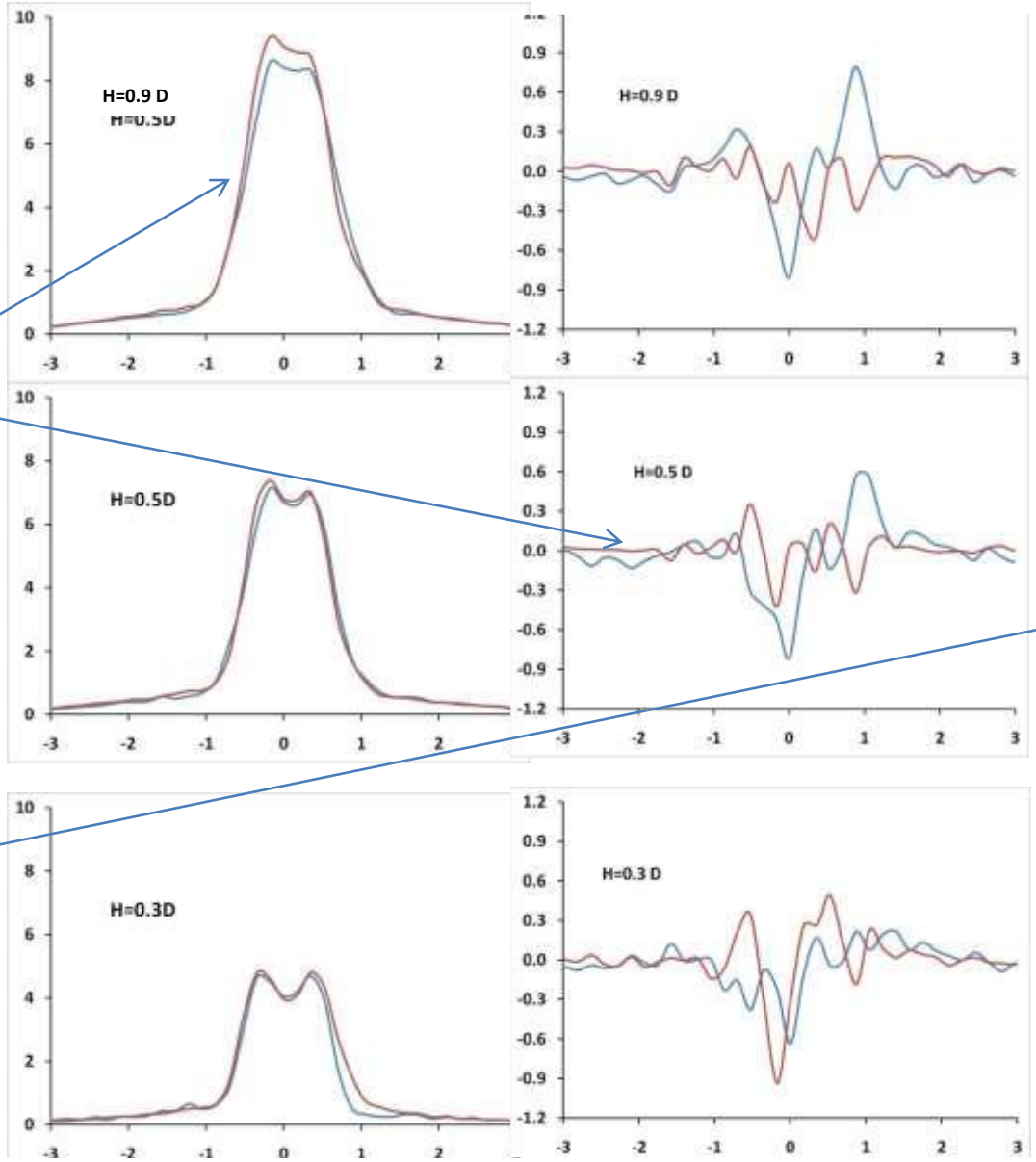


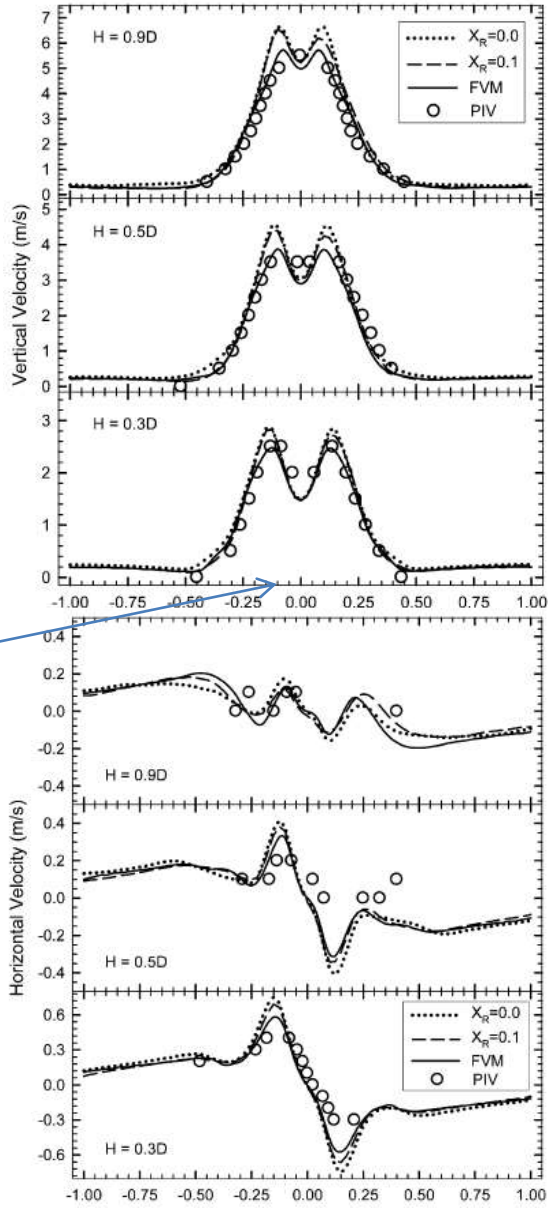
Literature Comparisons



FDS H & V profiles along 12 m side for porous & solid North shown

PIV meas. & simul of 1m CH_4 pool fire Xin et. al: 2008

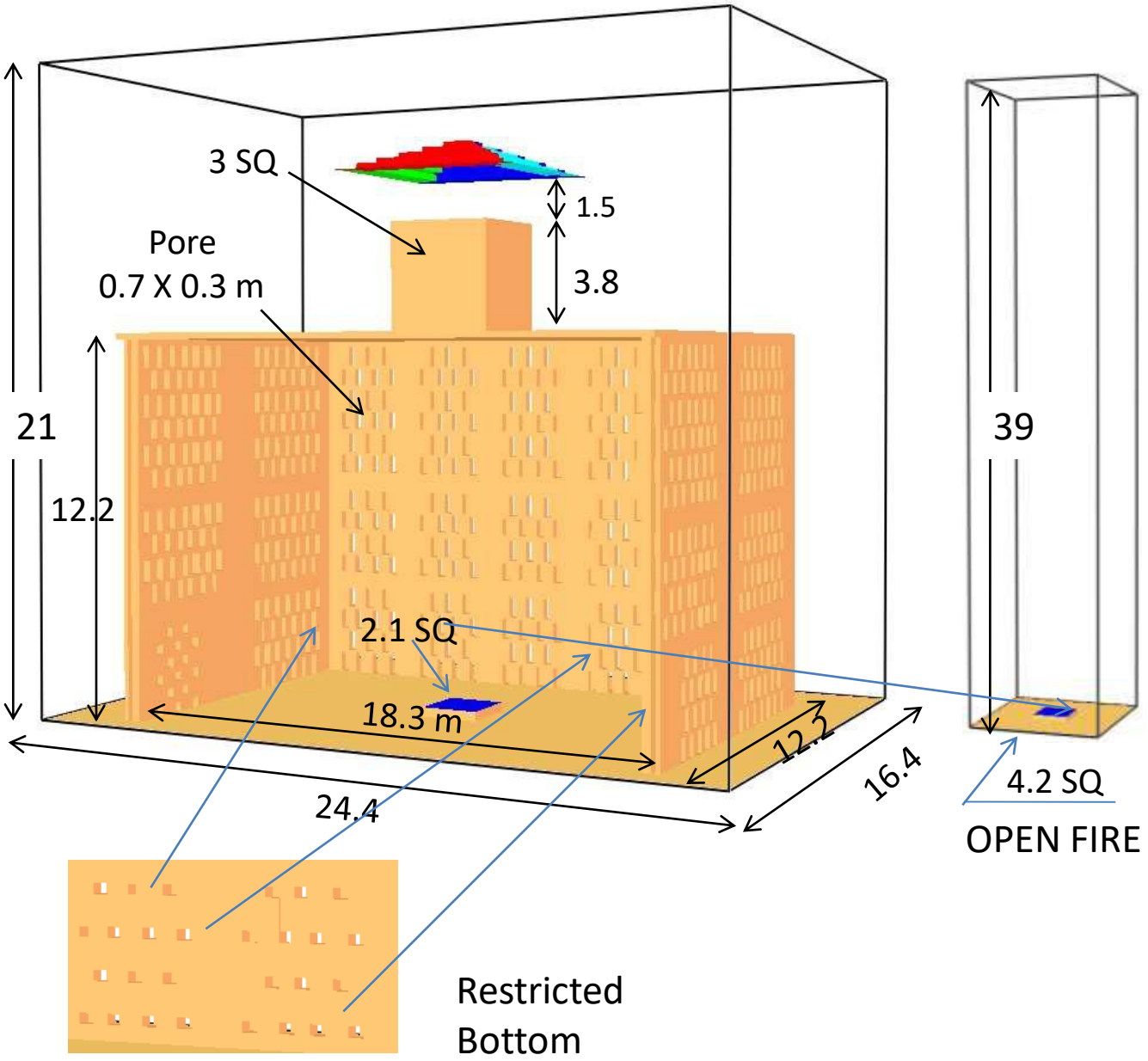




FDS – Porous Wall Facility

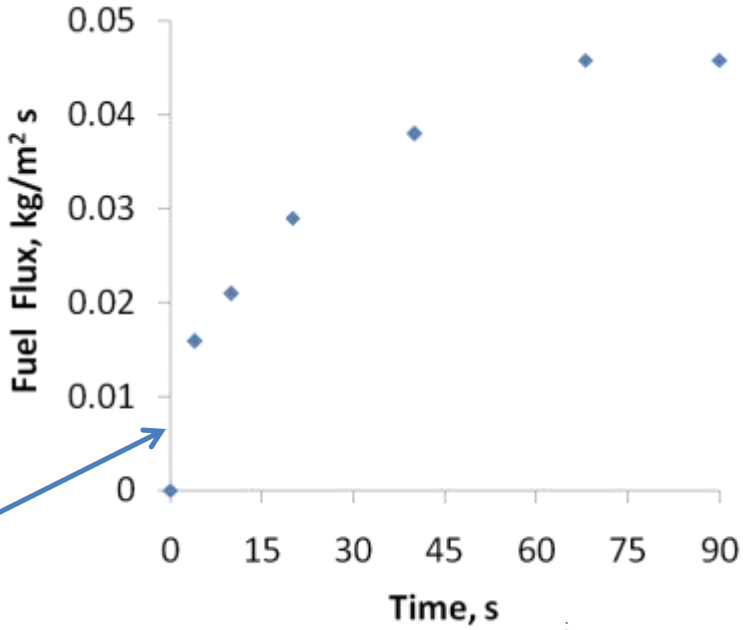
18.3 m x 12.2 x 12.2 m high, 3 m sq chimney
Calculations with refined mesh (0.1 m Sq) in fire region – 4 m width (X & Y)

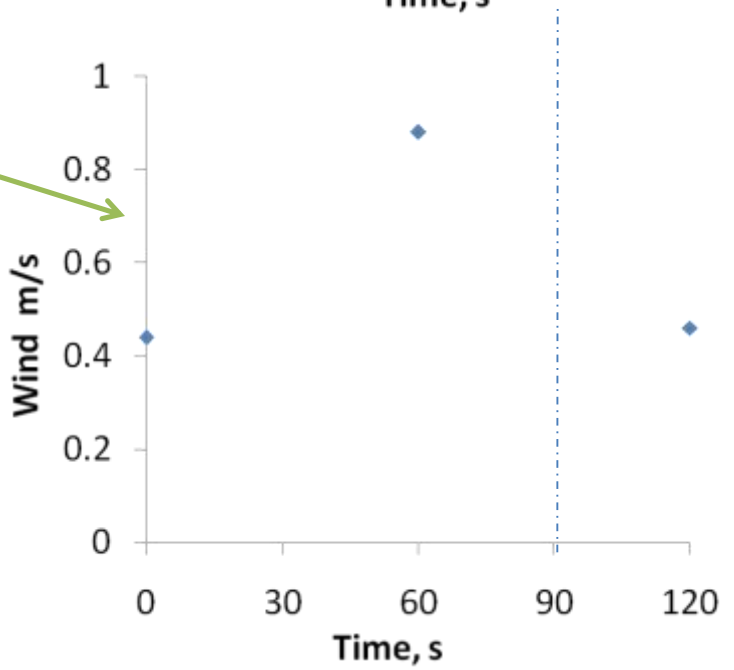
Mesh size: 100 mm in fire region 150 mm else where
(3.2 million cells)



Boundary Conditions

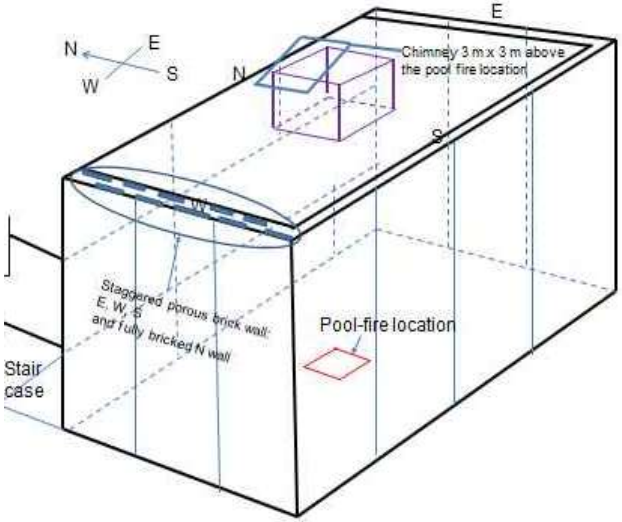
- Calculations performed:
  - JFL – Fuel: 72 g/m^{2}s
  - Open pool fire: 72 g/m^{2}s
  - Ramped Flux (up to 65% by 1st min)
  - Still & Windy Boundaries
  - JFL - Restricted bottom region
- End time of all calculations - 90 s

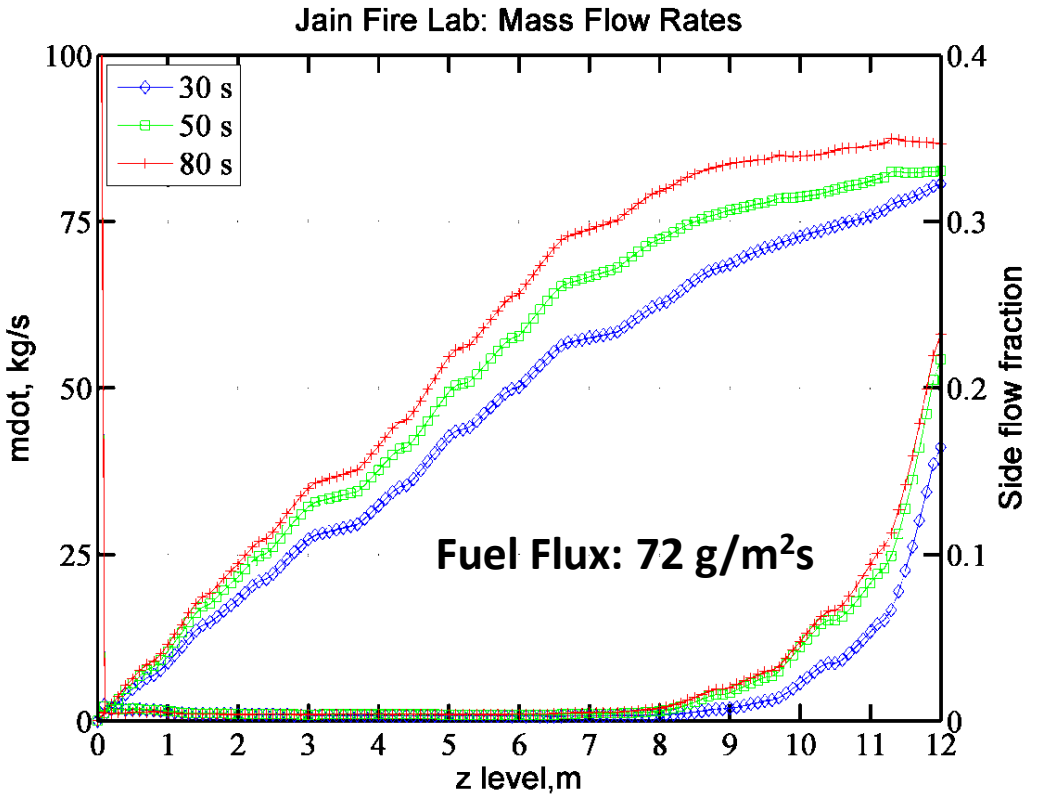


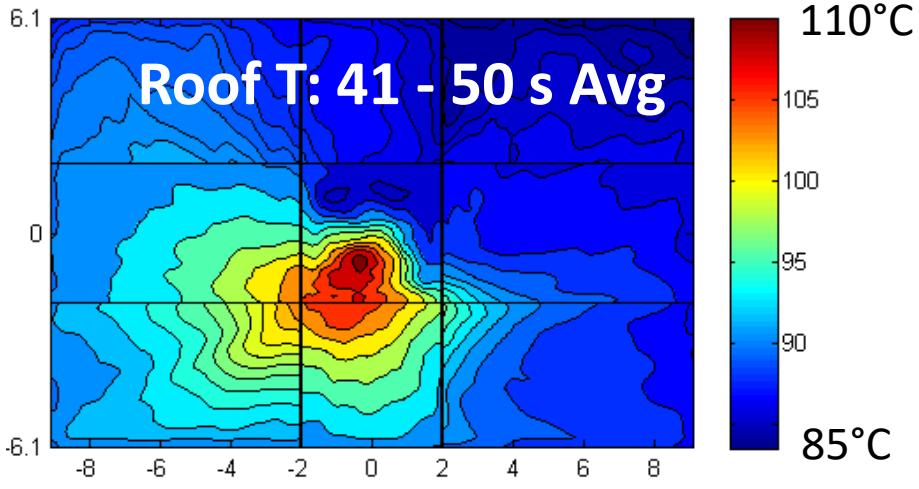


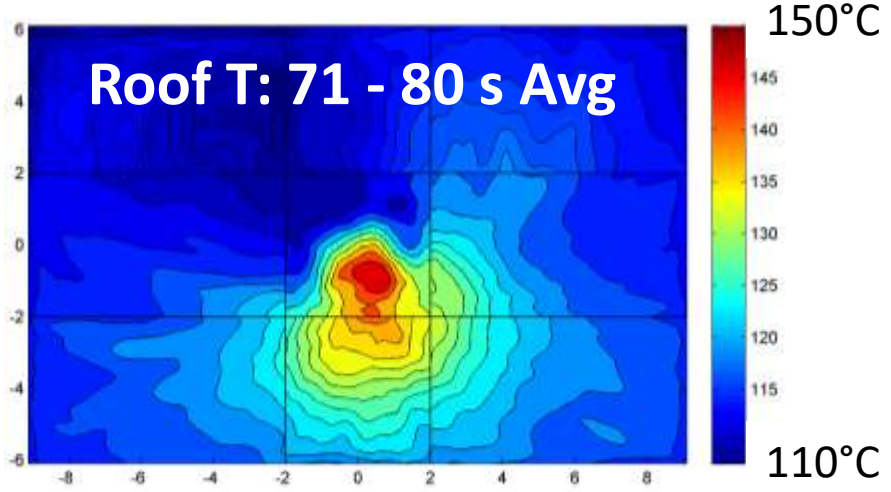
JFL – 72 g/m²s

- Mdot increase with amb T -> Buoyancy; Stabilize by ~90 s



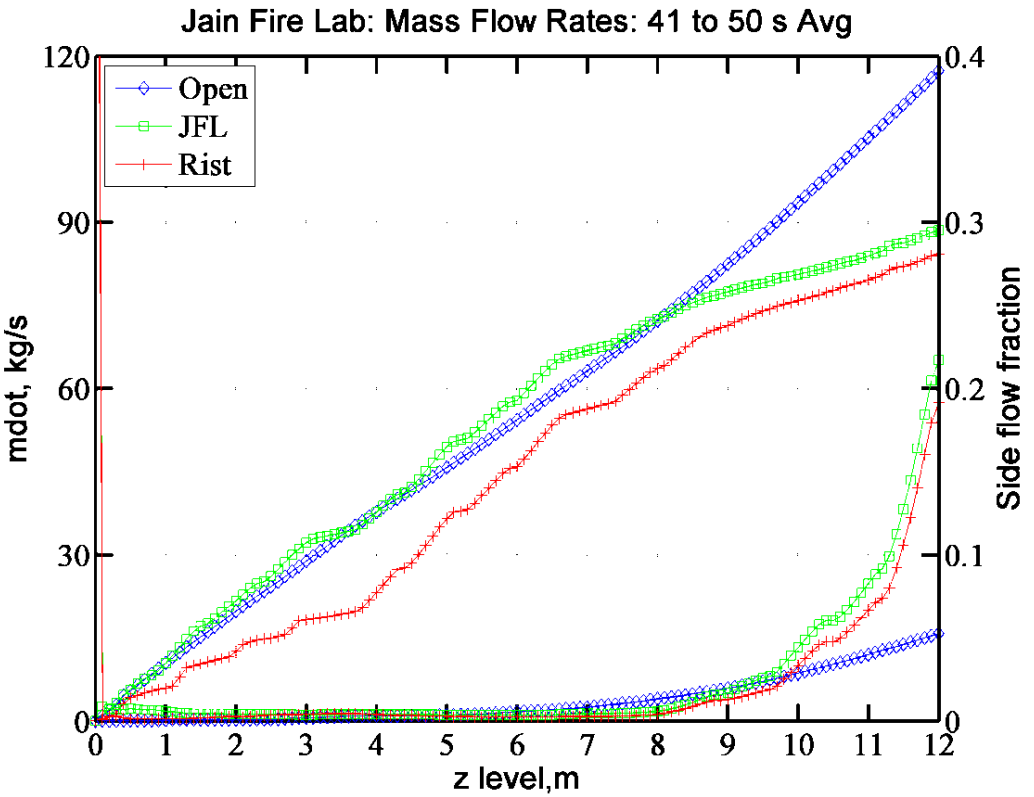






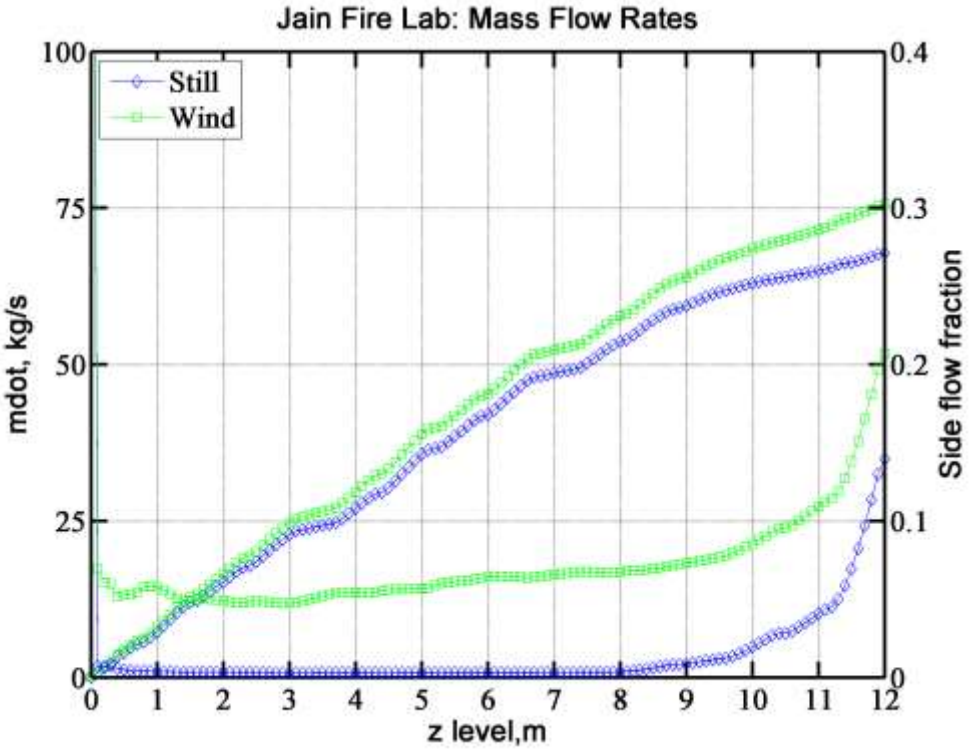
JFL – Mass Flow Rates

- 41 - 50 s average flow rates compared
- JFL indoor flows comparable till 7 m height beyond which, indoor flows fall dues to roof effects
- Additional restriction in bottom zone has resulted in small changes
- Mass flow rate plateaus seen to coincide with S,W & E wall blockages



JFL: Wind Effects

- Calculations with wind has shown about 5% increase in side flow fraction for imposed ambient wind of ~ 0.8 m/s
- 60% lower fire power has resulted in ~ 11% lower peak mdot during averaged 41 – 50 s period for still air
- Wind has contributed to ~5% increase in peak mdot

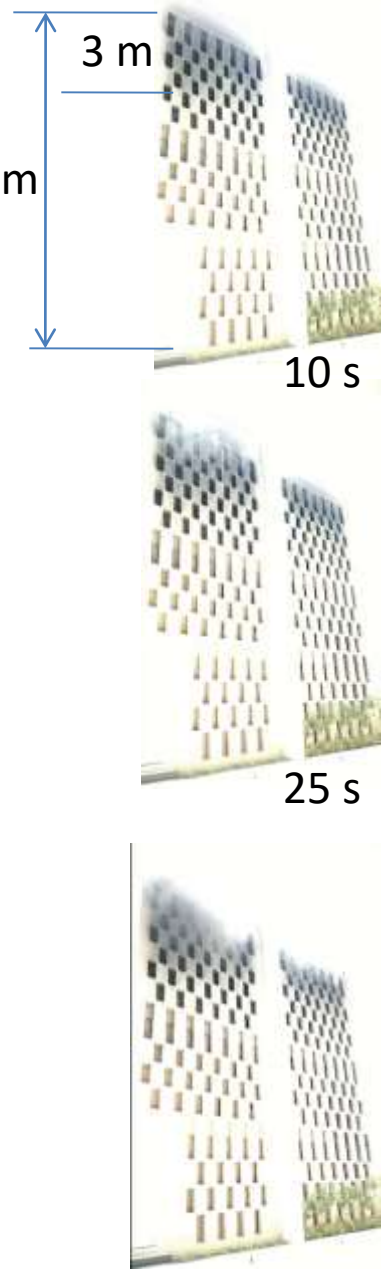


Still Ambient 70-80 s

Wind: 70 -80 s

direction

Porous Wall: Smoke Egress



- East, South & West sides of porous wall simultaneously videoed
- Windy ambient outdoors: velocities exceeding 2 m/s
- Smoke egress seen first at ~11 s through west wall and 8 s through south wall - coincides with calculations

West View

Summary

- Minimizing ambient wind disturbances in fire tests discussed
- Effect of wall pore size on smaller fire appears significant during random wind events
- Studies focus on minimizing this effect by suitably reducing pore size
- Studies are in progress to provide a scientific basis for selection of nature of porosity

Thank You