D^3 design

Design of an atrium

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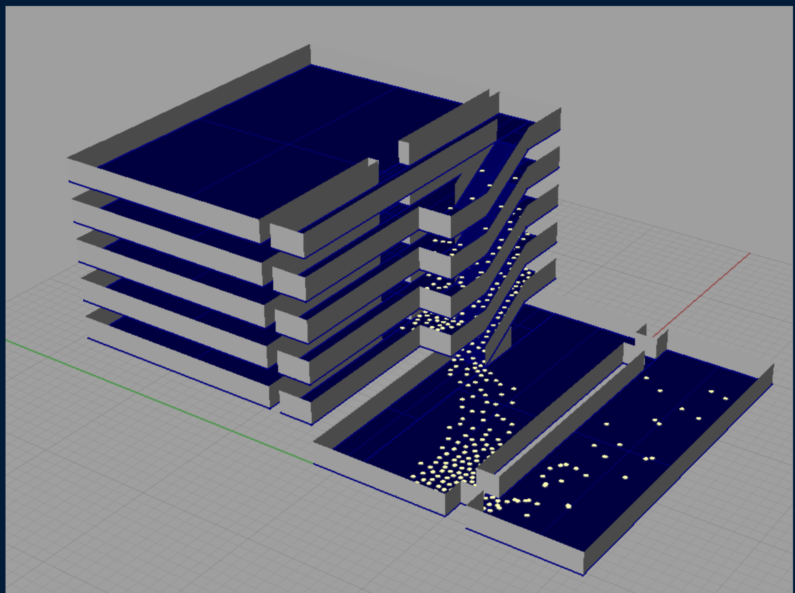
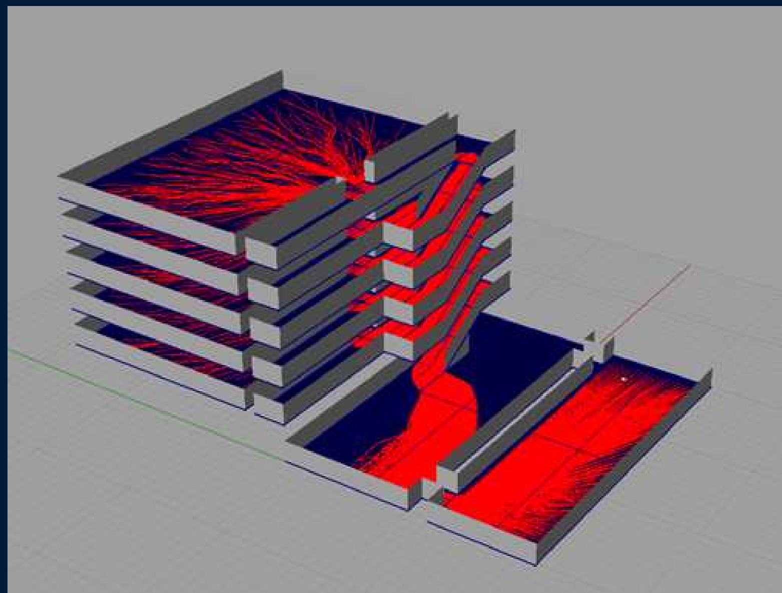
SMARTMOVE – egress simulations

Scenario B - 1 stair, 3m width at one end

	Hand Calculations	SMARTMOVE
5^{th} Floor Evacuation	• Last person starts to exit – 200 seconds • max distance from room exit – 25m • 20m from exit to start of stair • 45m/1.3m/s – 35 seconds • 235 secs top floor evacuation 3 mins 55 secs	3 min 50 secs
4^{th}	• Length of stair - 7m (0.9m/s) – 8 seconds • Stair to stair – 24.5m (1.3m/s) – 19 seconds 4 min 22 secs	4 mins 14 secs





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Total evacuation

Hand Calculations

Flow calculations

Quickest

- First person leaving will leave at 1p/sec
- After 27 secs flow increase to 2ppl/sec
- After 54 secs flow is at 3ppl/sec
- After 81 secs flow is still at 3ppl/sec max flow at exit (2m wide, reduced to 1.5m for people to move, each person 0.5m wide)

- In 81 secs – 162 people leave
- If we assume that everyone else leaves at 3ppl/sec
- 1000-162 = 838 ppl left
- 838/3 = 280 secs
- 280+81 = 361 secs
- Shortest time to start exiting (1st floor to exit)40 secs
- Total 401 seconds

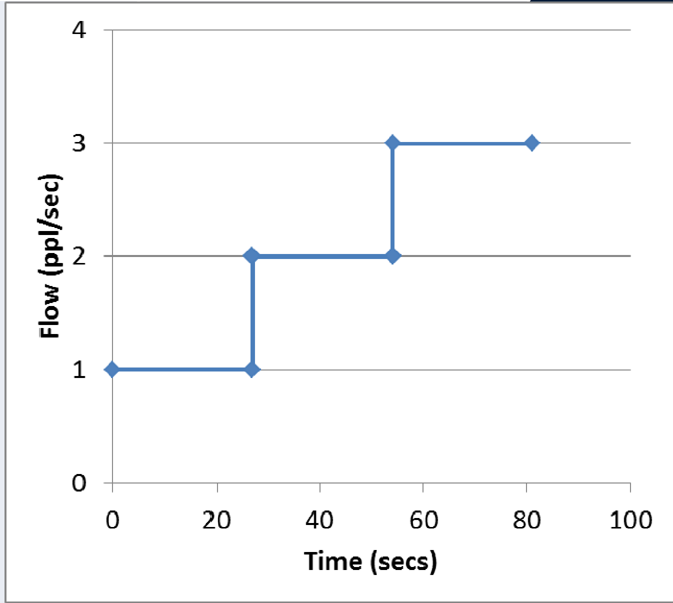
6 mins 41 secs

Slowest

- Assume that end flow is same as initial flow
- 81 secs 162 people leave at start and end of flow
- 1000-162-162 = 676 ppl left
- 676/3 = 226 secs
- 226 + 81 + 81 = 388 seconds
- Longest time to start exiting 60 seconds (room corner 1st floor to exit)
- Total 448 seconds

7 mins 28 secs

SMARTMOVE



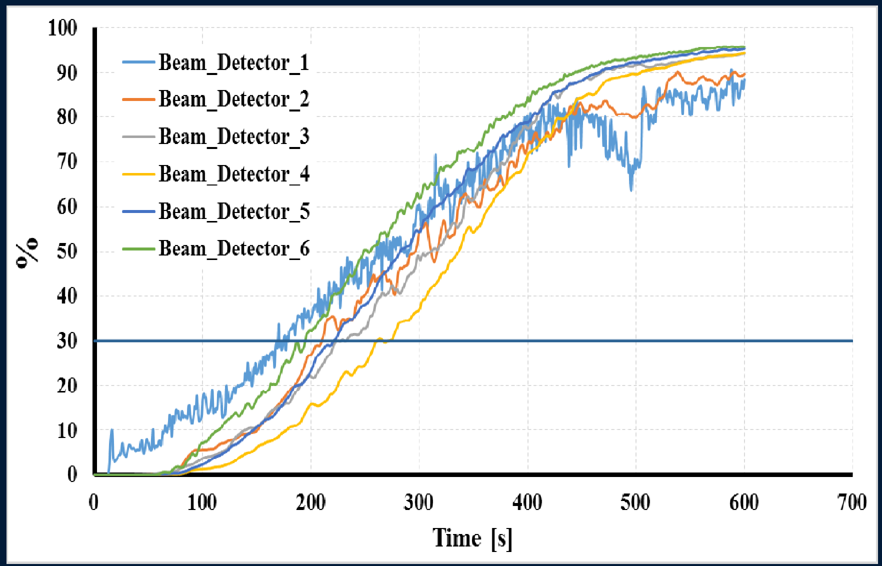
7 mins 02 secs

FDS – smoke simulations

- Scenario B
  - 2MW fire, Under balcony, Natural ventilation
    - 6no. 1.5m x 1m openings in roof (2 rows of three openings)
      - $9m^2$ of ventilation
    - 1 opening in wall (2mx2m door on ground floor)
- Results
  - 5th Floor visibility >70% after 3 mins 15 secs - Less than evacuation calculations
  - 4th Floor visibility >70% after 3 mins 41 secs - Less than evacuation calculations
  - Max gas temps of slice in middle of room 83°C
    - Not enough bouyancy to drive gases through natural ventilation systems
  - Beam detectors – time=180 s – 300 persons can evacuate the building;
    - Considering slice files for the visibility –situation may not be that critical –
    - In general the observed visibility is equal or greater than 25 min.

<u>Issues not considered:</u>
No toxic gas analysis
Don't know height of smoke on each balcony

<u>Recommendations:</u>
Mechanical smoke control (maybe in walls rather than ceilings as building is high)
Increase the exit width of the building to match the stair width of 3m



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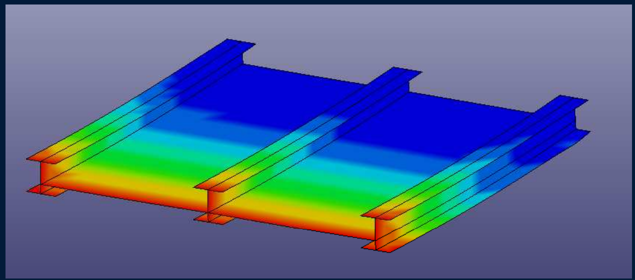
LS-DYNA – structural modelling

- Scenario B
  - ISO fire
  - Hot bottom only
  - 100% load
  - Minimum of 30 mins for fire fighters
- Results
  - First model didn't work
  - 2nd analysis crashed at 4am
  - 196 secs of time assessed
  - Balcony goes UP 10 cm after 3 minutes due curvature and axial elongation of hot bottom flange?
  - NOT CORRECT!



- Recommendations
  - Protect steel with intumescents?
  - Increase size of steel members?
  - **Redo the analysis**

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Thank you for your attention
Any questions?

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