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An applied methodology for the inclusion of **travelling fires** in the fire safety design process of a building

STRUCTURES IN FIRE FORUM

STRUCTURES IN FIRE FORUM – 10TH APRIL 2026

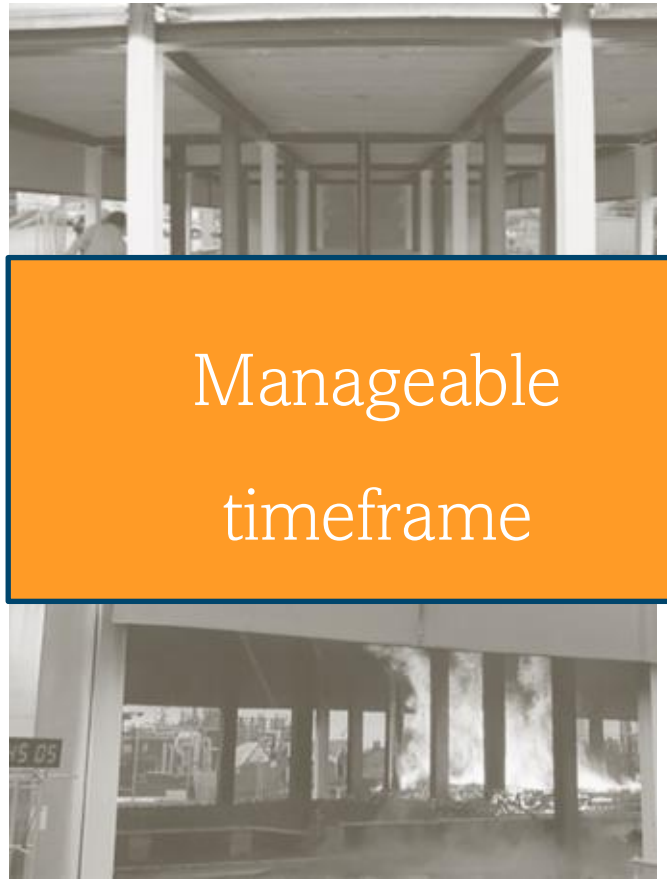
THE DIAMOND, 32 LEAVYGREAVE RD, BROOMHALL, SHEFFIELD S3 7RD

How does fire behave in large compartments?

NOT as in a furnace

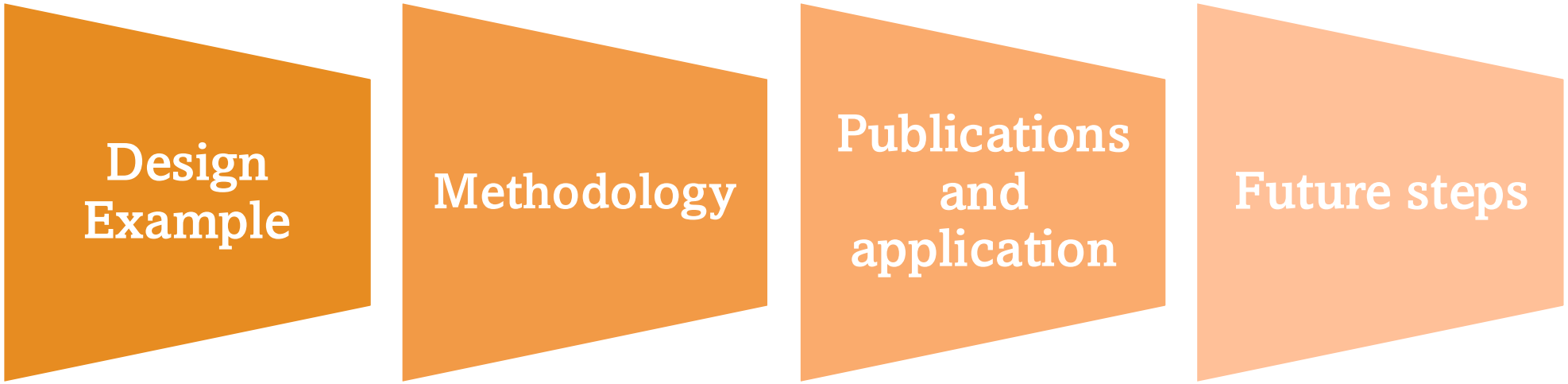
What do we need?

Accurate models



Manageable timeframe

An applied methodology for the inclusion of travelling fires in the fire safety design process of a building



Design example

9 x 15 m

Open sides

Office fire load

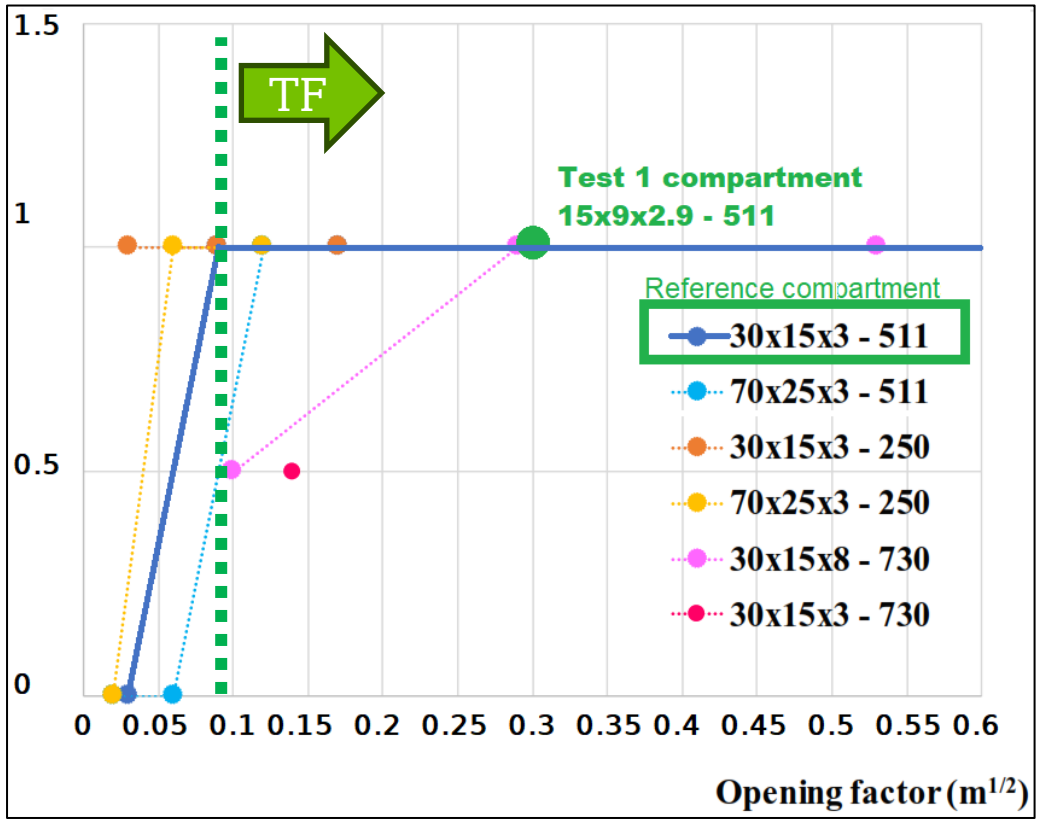
Unprotected steel column

Stage 1: Evaluate occurrence of a travelling fire

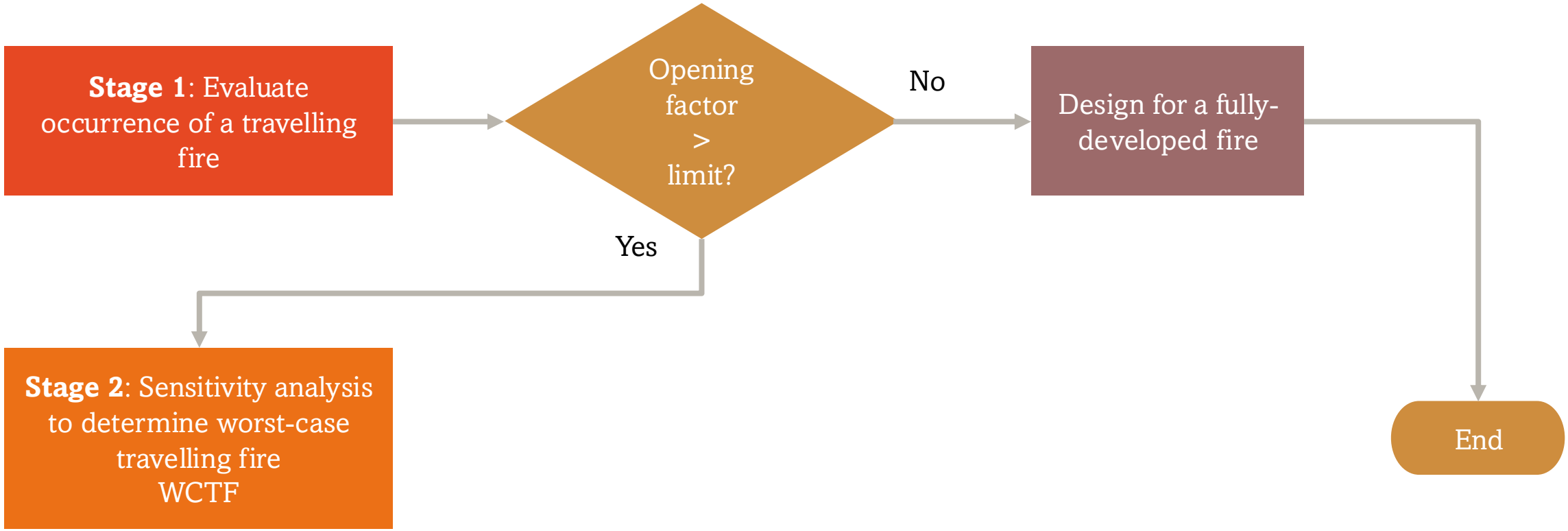
Opening factor > limit?

- Reference compartment
- Limit opening factor = 0.09 $m^{1/2}$
- O = 0.3 $m^{1/2}$
- **TF more likely than fully developed**

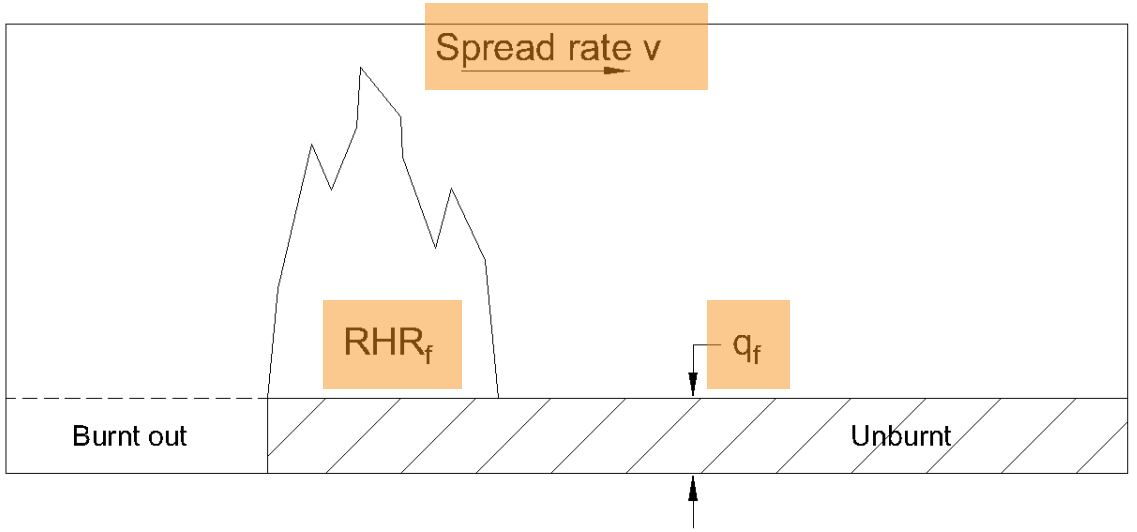
$$O = \frac{A_v\sqrt{h_{eq}}}{A_t}$$



Charlier, 2022 - Parametric study


Stage 1: Evaluate occurrence of a travelling fire
Opening factor > limit?
No
Design for a fully-developed fire
Yes
Stage 2: Sensitivity analysis to determine worst-case travelling fire WCTF
End

Stage 2: Sensitivity analysis to determine worst-case travelling fire WCTF

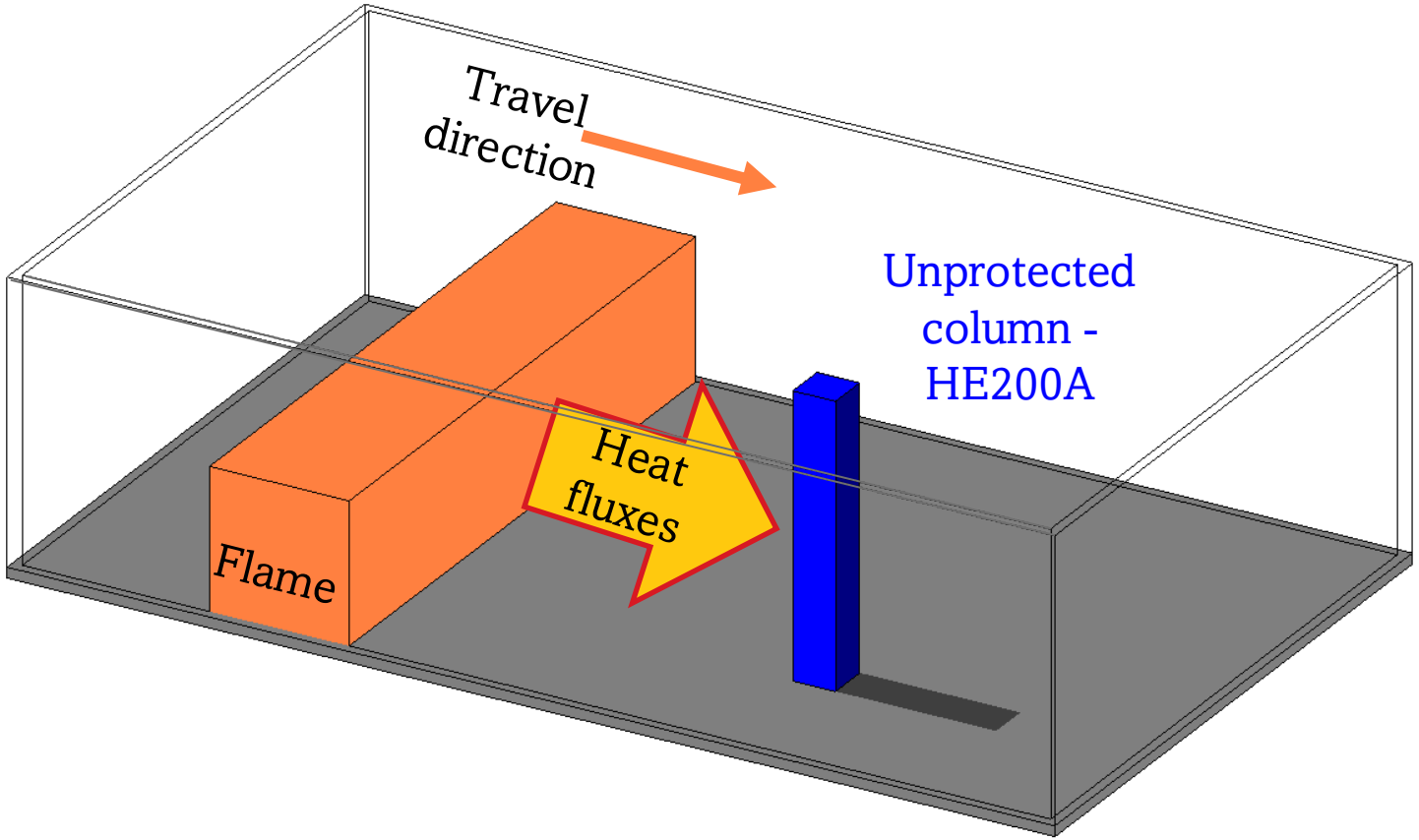


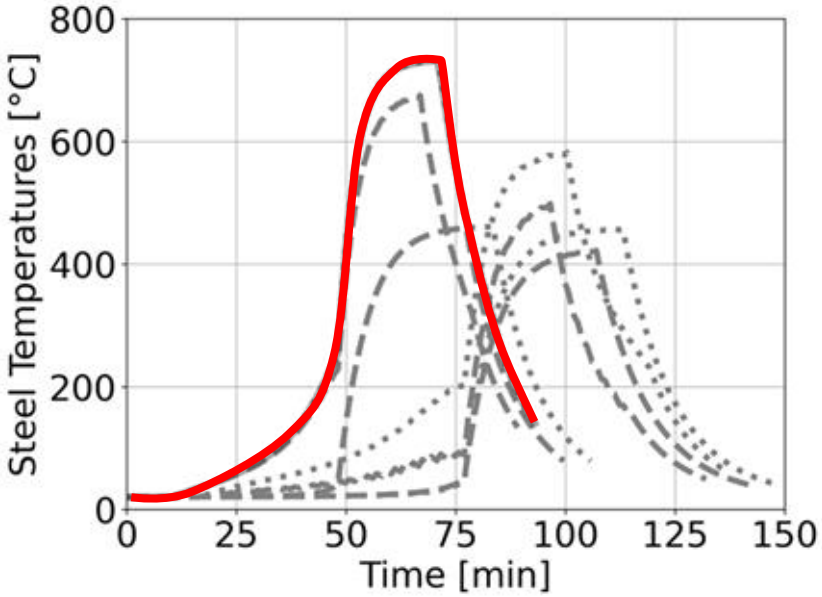
Heat release rate per unit area RHR_f	Fuel load density q_f	Spread rate v
EN1991-1-2 Annex E 250 kW/m^2	EN1991-1-2 Annex E Avg = 420 MJ/m^2 80% = 511 MJ/m^2	Charlier, 2022 Parametric study 2 – 9 mm/s
Test data 400 kW/m^2		

Stage 2: Sensitivity analysis to determine worst-case travelling fire WCTF

→ Structural response TRAFIR model

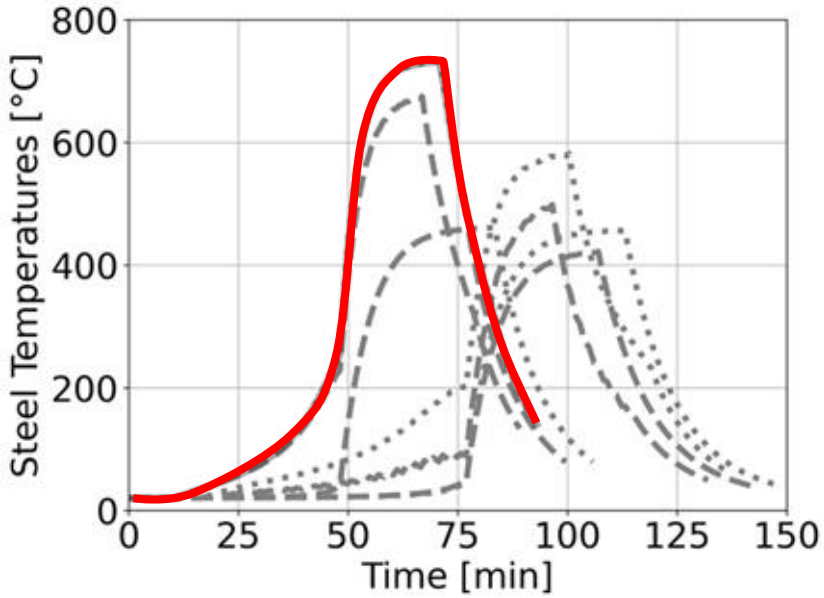
- EC1 and EC3 equations
- Section factor of 211mm^{-1}
- Steel properties EN 1993-1-2
- T @ 2.5m height

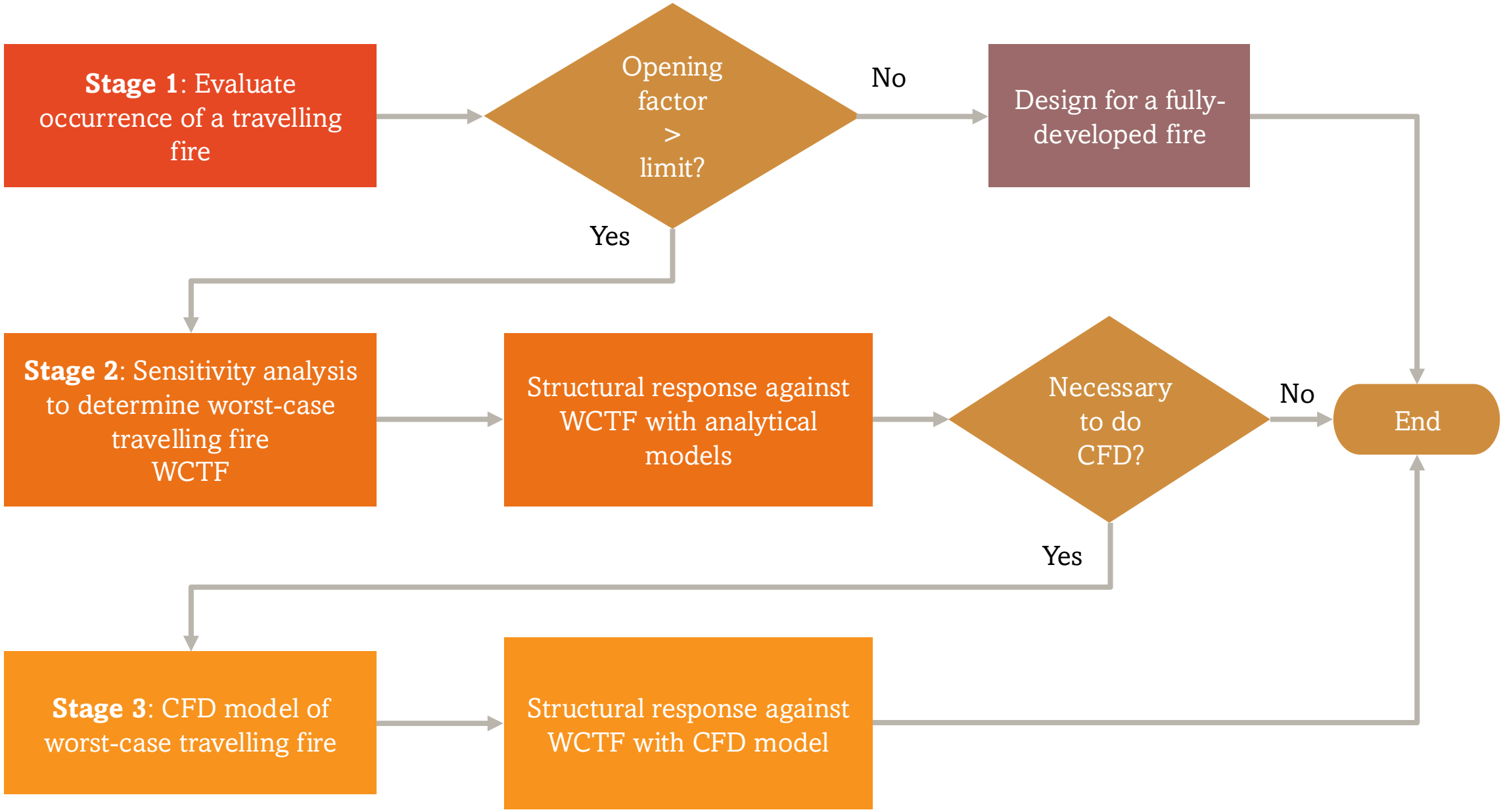




Stage 2: Sensitivity analysis to determine worst-case travelling fire WCTF → Structural response TRAFIR model → Worst-case travelling fire WCTF

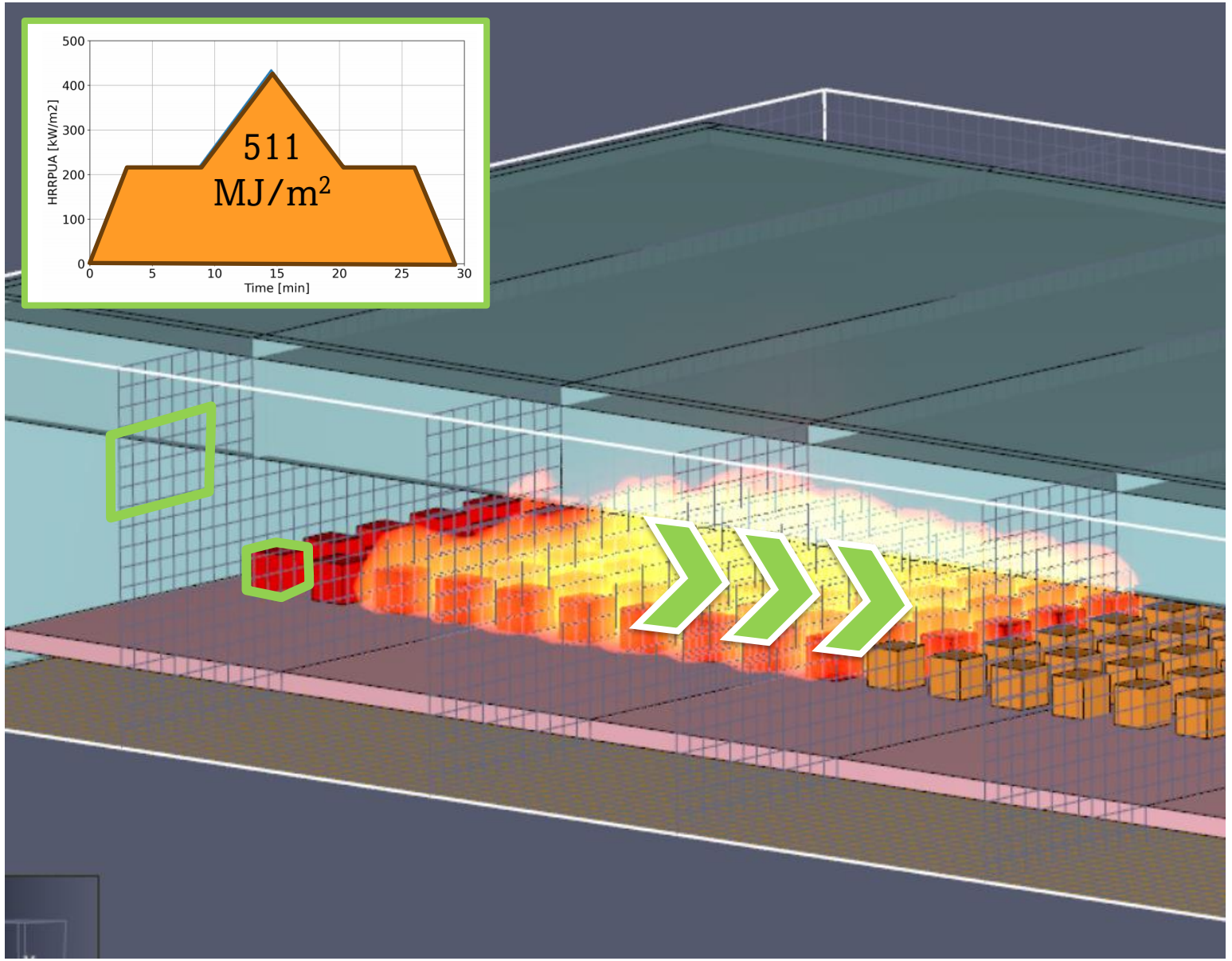
q_f [MJ/m^2]	RHR_f [kW/m2]	v [mm/s]
511	400	3.5




Stage 1: Evaluate occurrence of a travelling fire
Opening factor > limit?
No
Design for a fully-developed fire
Yes
Stage 2: Sensitivity analysis to determine worst-case travelling fire WCTF
Structural response against WCTF with analytical models
Necessary to do CFD?
No
End
Yes
Stage 3: CFD model of worst-case travelling fire
Structural response against WCTF with CFD model

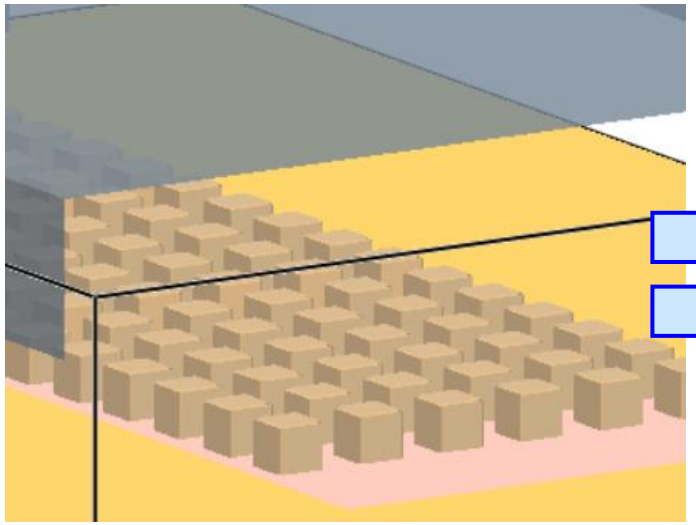
CFD models for more data availability

- Simplified fuel load: timber cubes 32cm
- Prescribed HRRPUA for office
- Fire spread: timer-controlled
- 16cm mesh – 170k cells
- D*/dx + turbulence resolution



Stage 3: CFD model of Worst-Case Travelling Fire → Fire spread model

- Simplified representation
- High uncertainty in heat transfer and fire spread



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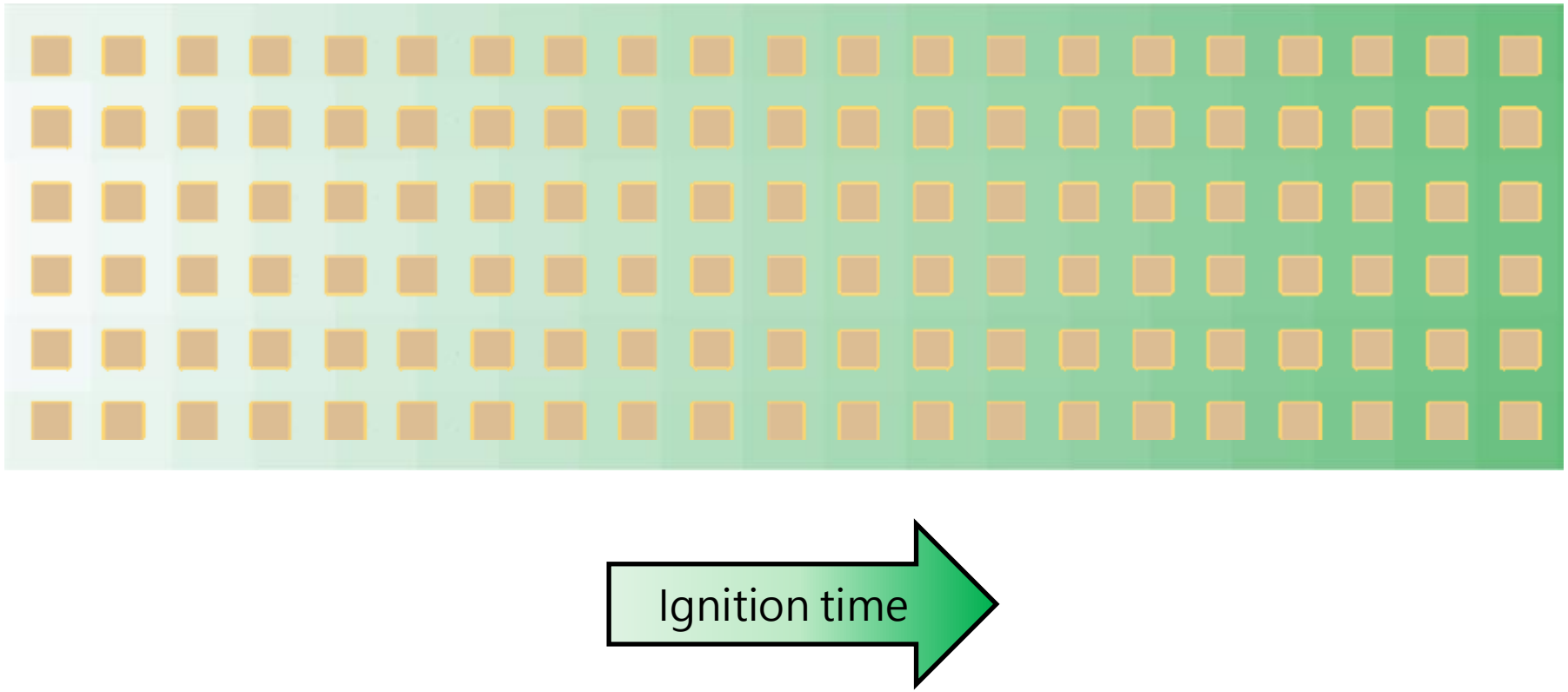
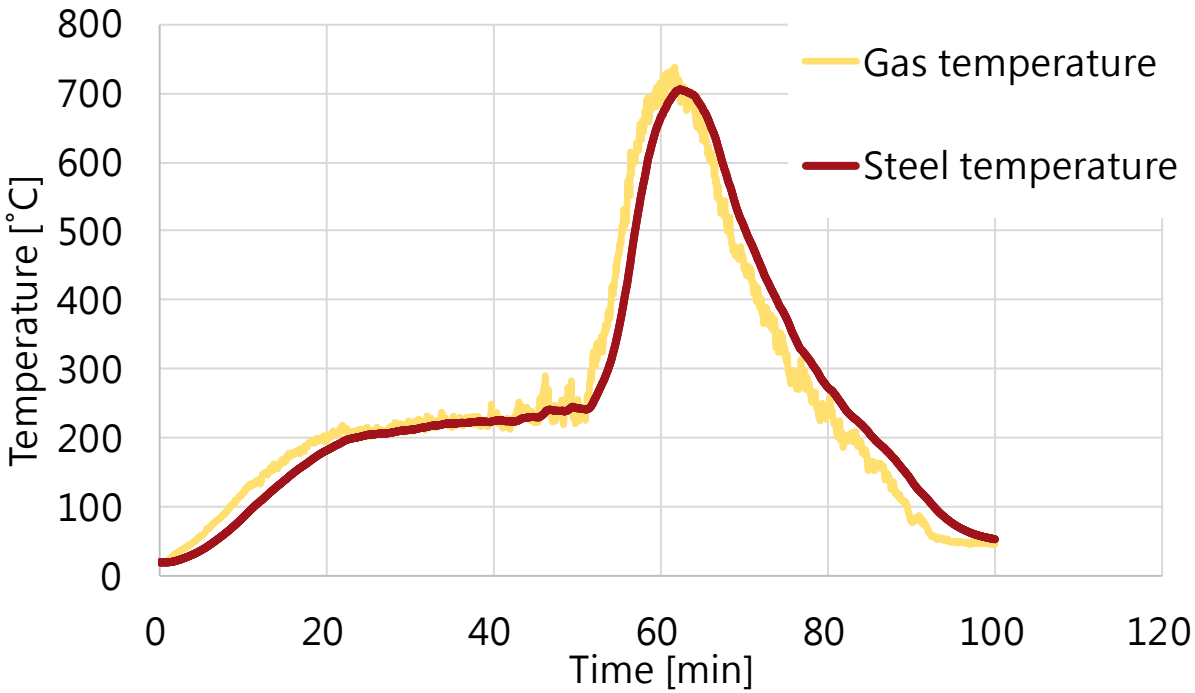
Stage 3: CFD model of Worst-Case Travelling Fire

Fire spread model

Prescribed travel speed using timer control logic

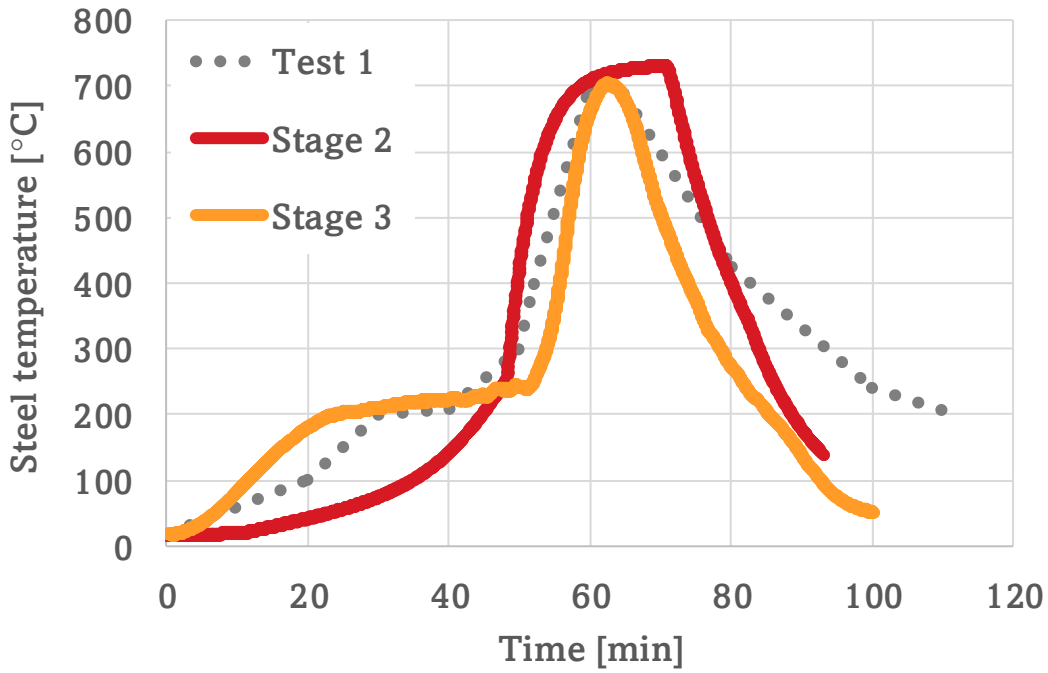


Stage 3: CFD model of Worst-Case Travelling Fire → Fire spread model → Prescribed travel speed using timer control logic → Structural response



Outcome of the design process

- Test results shown for comparison
- Stage 1: TF more likely than fully-developed fire
- Stage 2: WCTF characterised rapidly by analytical models
- Stage 3: more data availability about fire exposure



Publications about this research

Application in industry

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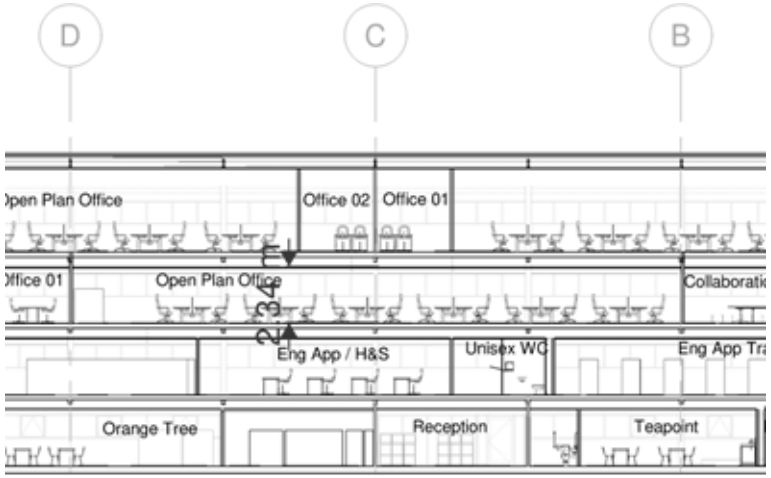
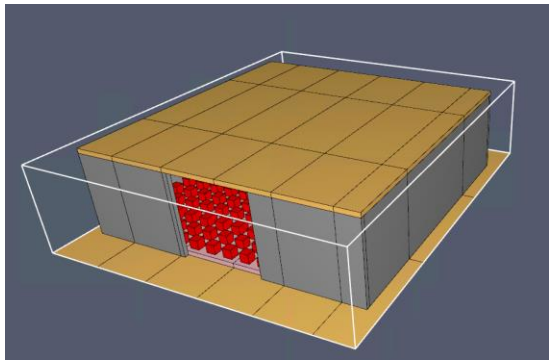
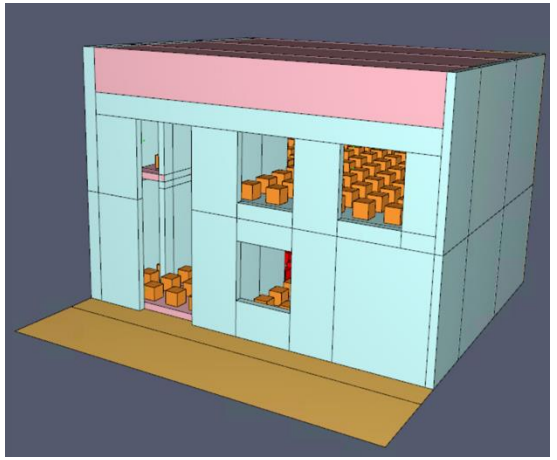
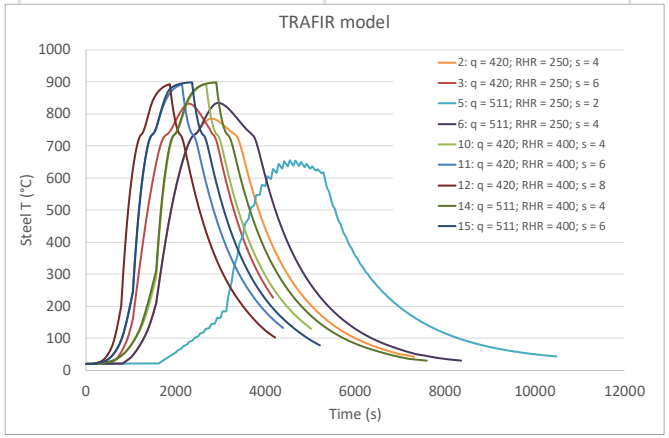
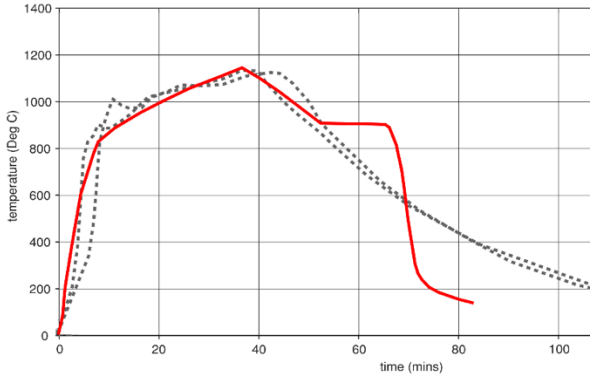
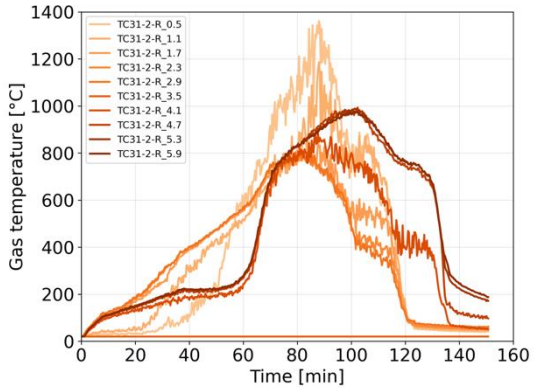




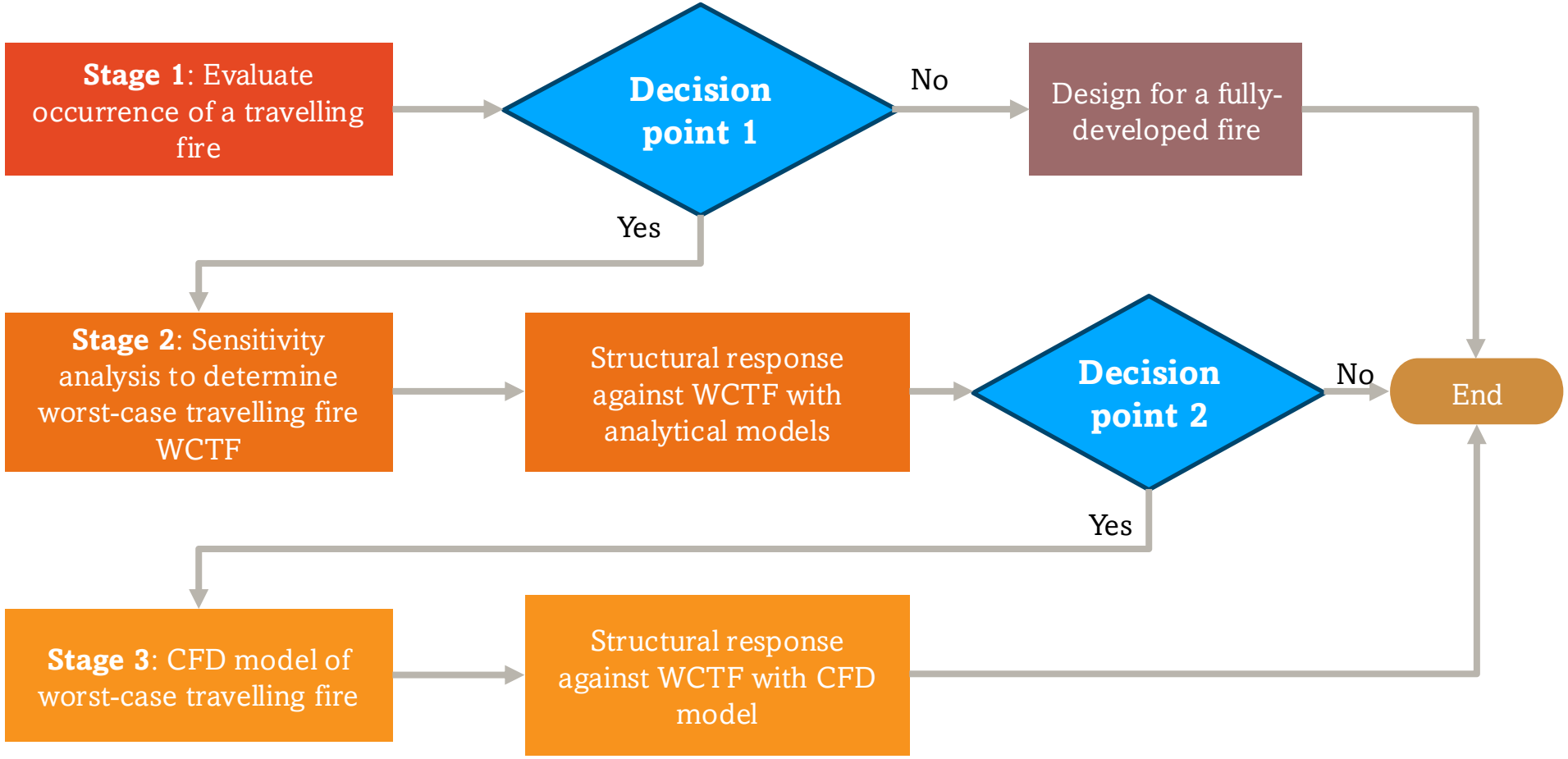








Areas of refinement



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Questions?

Thank you