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ROLE OF CFD IN THE QUANTITATIVE ASSESSMENT OF STRUCTURAL PERFORMANCE IN FIRE SCENARIOS

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MOTIVATIONS

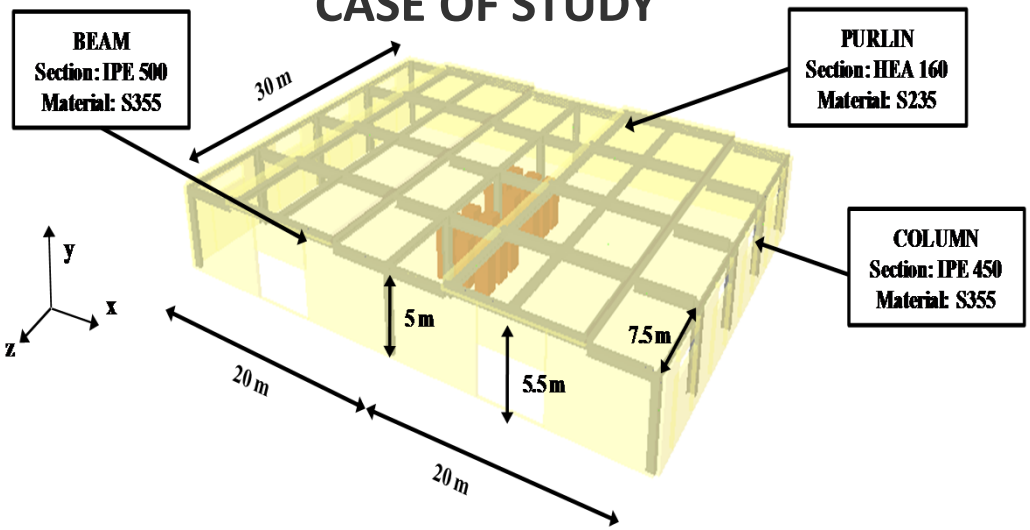
The **quantitative assessment** of the structural performance is based on a **multiphysics analysis**.
With the wide adoption of performance-based fire safety design, **CFD simulation** is becoming a routine practice for obtaining the necessary fire design information.

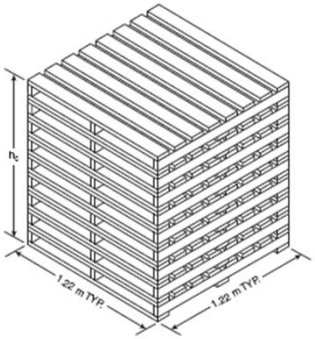
An adequate representation of fire can not ignore from the study of some factors:

- **Fuel Properties;**
- **Fuel Location;**
- **Ventilation.**

The numerical data should be compared with experimental results

CASE OF STUDY





FUEL PROPERTIES

Height	3.05m
Size	1.2m x 1..2m
Weight of one pallets	15 kg
Weight of one stack of pallets	300 kg
Weight of all stacks	5400 kg
$HRR_{s,max}$	6810 Mw/m^2
t_g	80 s

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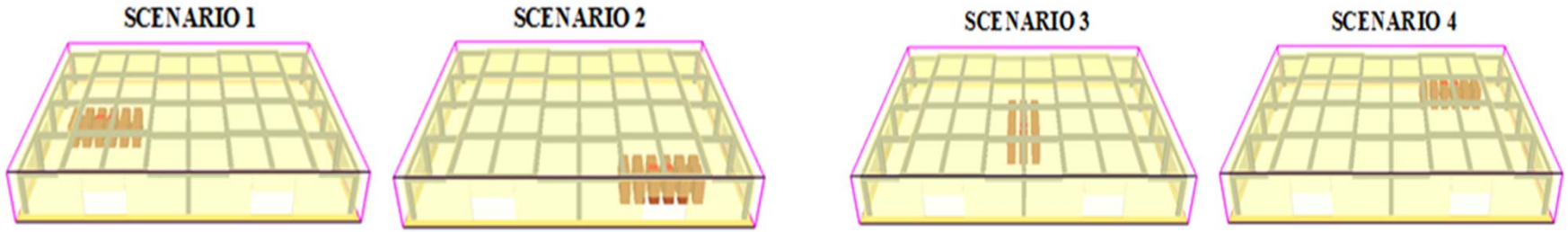
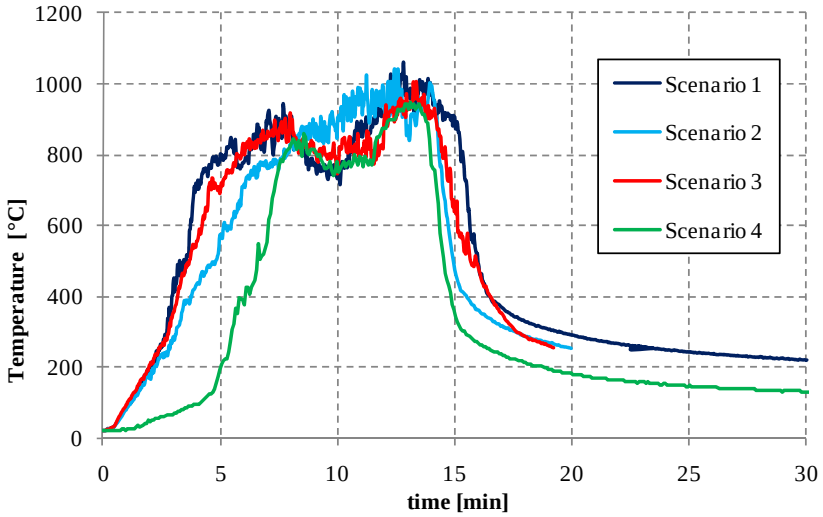
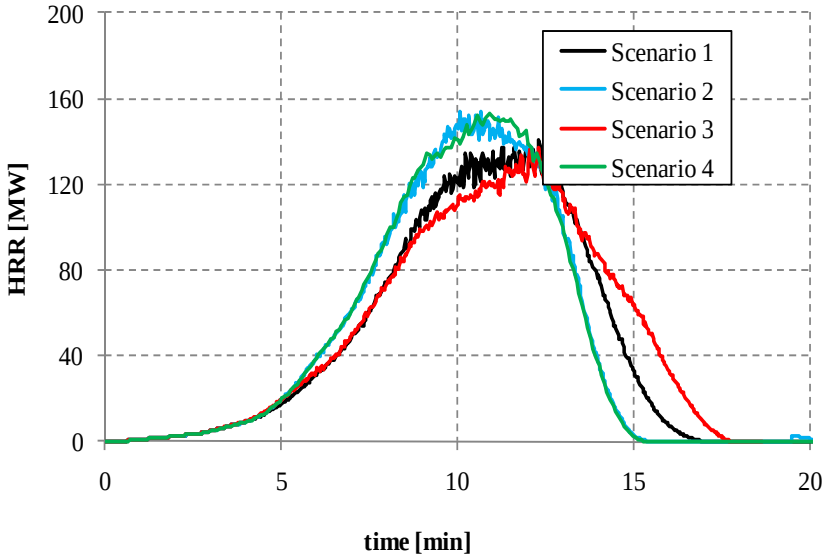
FUEL LOCATION – FIRE MODEL



TEMPERATURE



HRR



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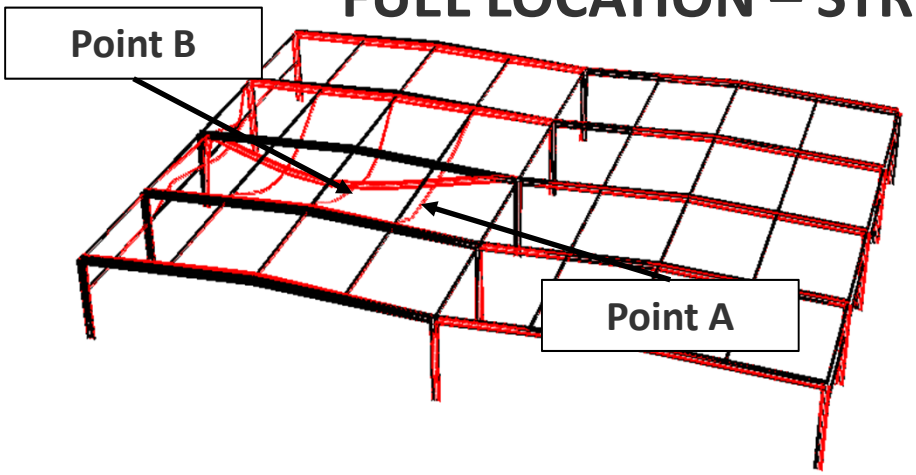
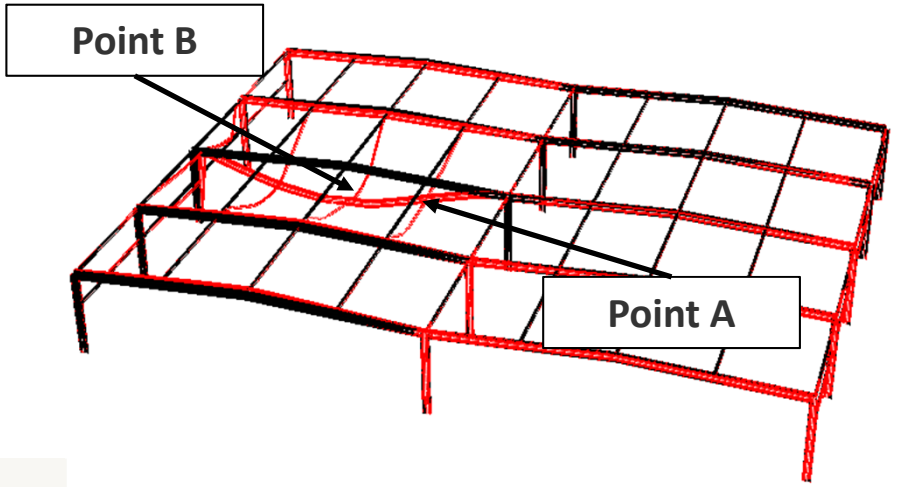
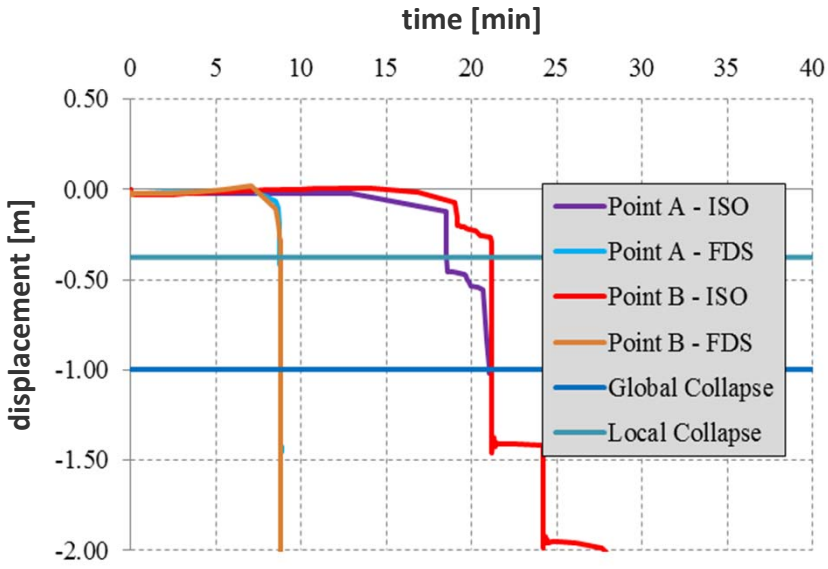
FUEL LOCATION – STRUCTURAL RESPONSE (I)



SCENARIO 1



ISO 834
Local Collapse: 18 min
Global Collapse: 22 min



FDS
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Global Collapse: 9 min

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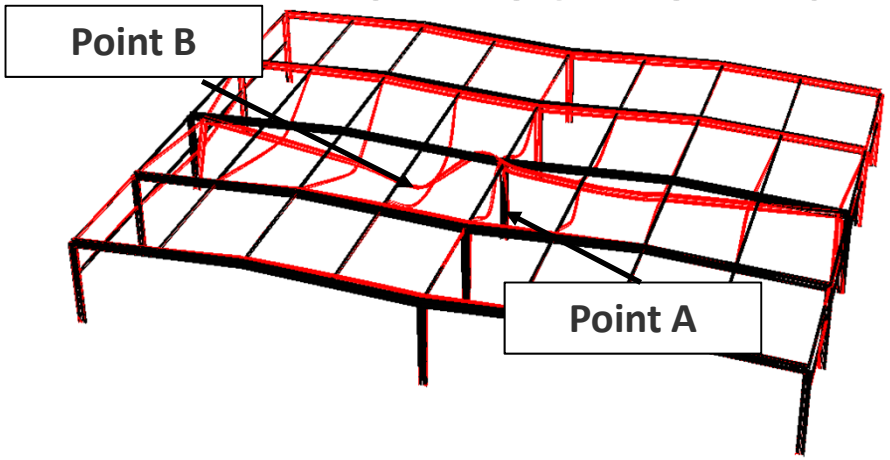
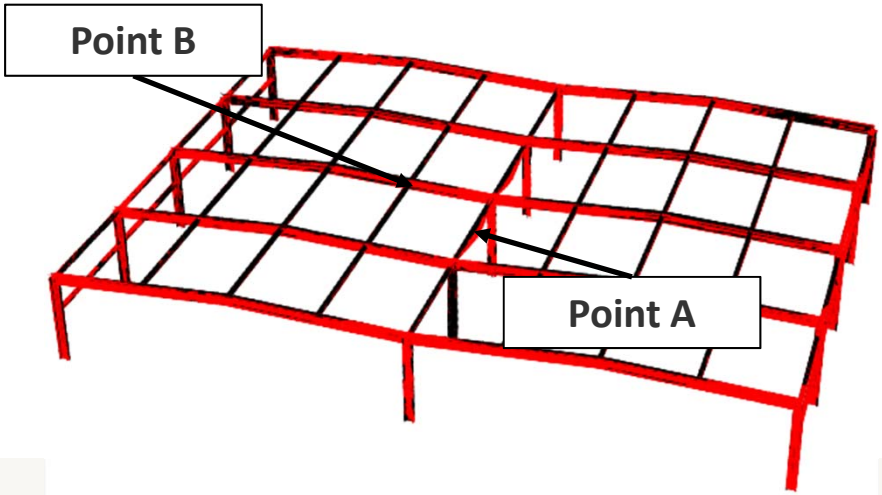
FUEL LOCATION – STRUCTURAL RESPONSE (II)



SCENARIO 3



ISO 834
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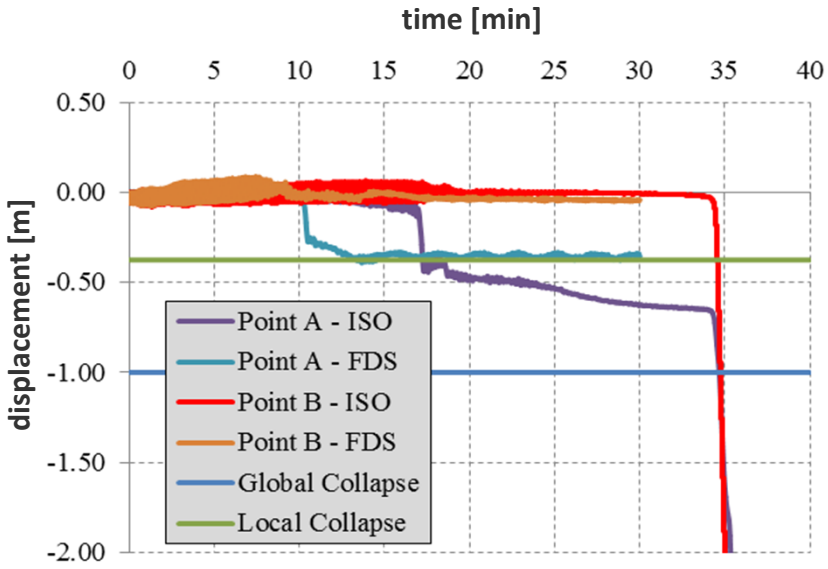

FDS
Local Collapse: 11 min
Global Collapse: --

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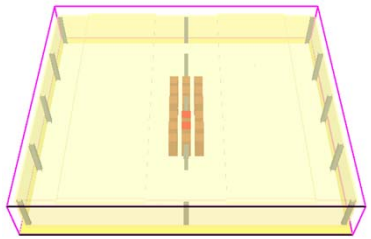
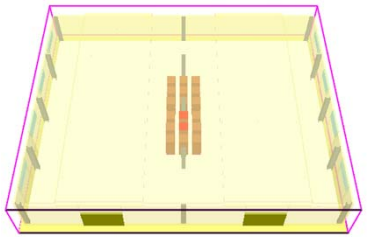
VENTILATION

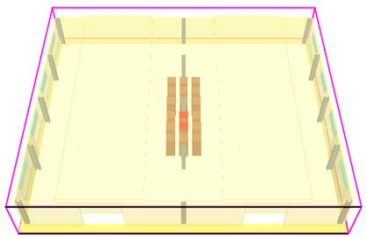
ALL OPENING CLOSED



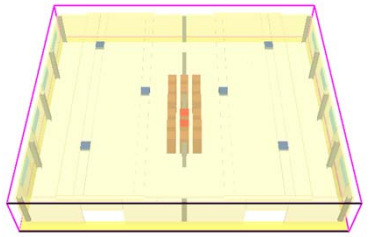
OPENING DOORS



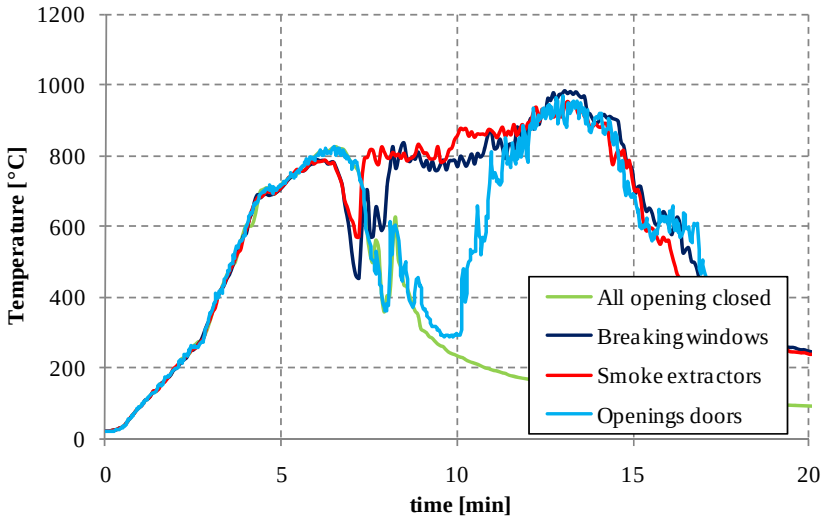
BREAKING WINDOWS



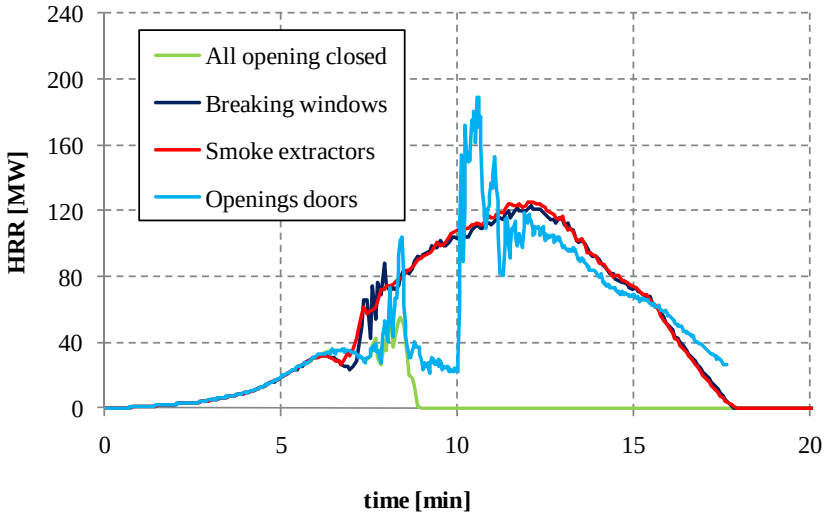
SMOKE EXTRACTORS



TEMPERATURE



HRR



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CONCLUSIONS

- CFD models permit a quite realistic representation of fire scenarios, because it takes into account the **distribution of fuel**, the **geometry** and the **occupancy** of individual compartments in a structure.

- The use of **standard fire** does not necessary give conservative results.

- An application on a steel structure shows that CFD allows a more **refined representation** of the fire compared to an analytical evaluation. It can consider issues relevant to the development of the fire and take into account significant **variations of the boundary conditions in time**.

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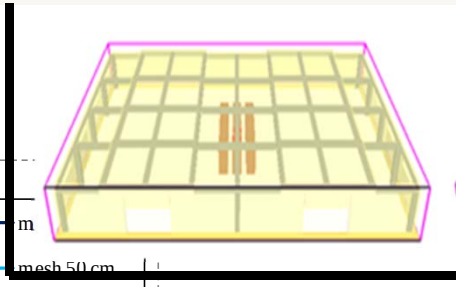
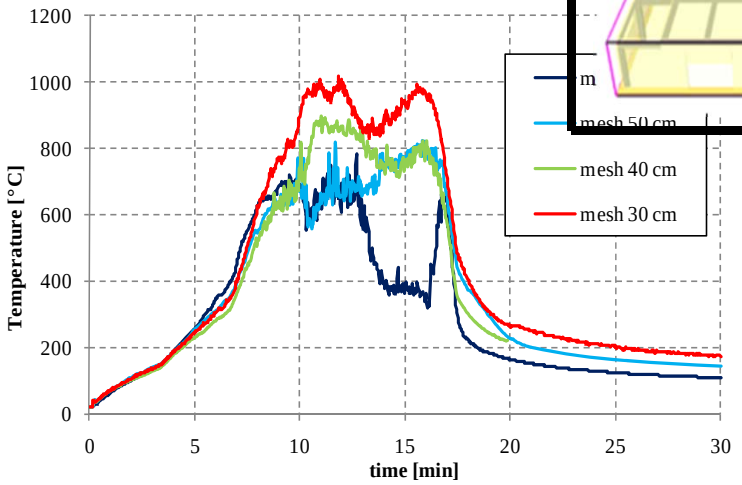
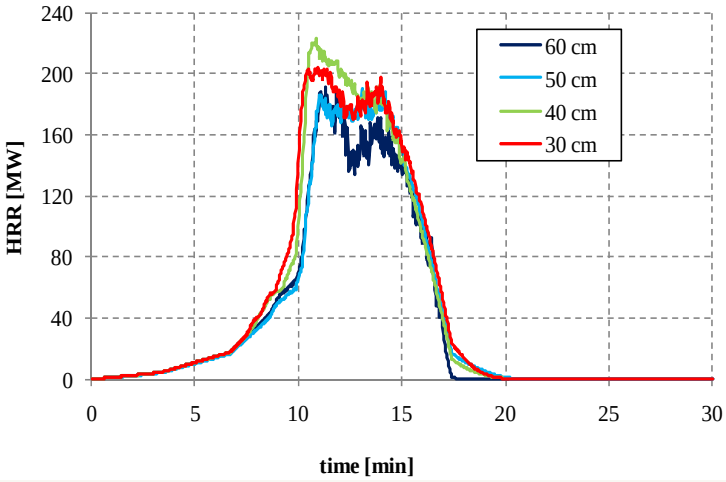
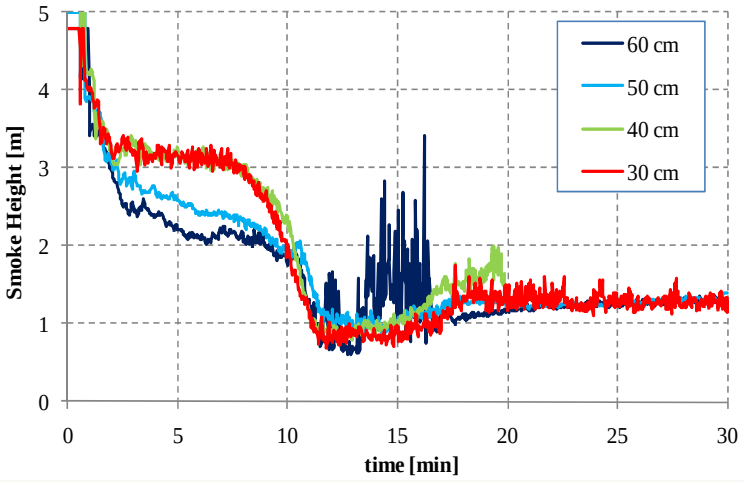
CALIBRATION AND OPTIMIZATION

dx	% D*	$\frac{dx}{D^*}$	Number of cells
0.3	0.15	6.89	298080
0.4	0.19	5.17	126360
0.5	0.24	4.14	64512
0.6	0.29	3.45	38880









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LITERATURE VS EXPERIMEMENTAL HRR

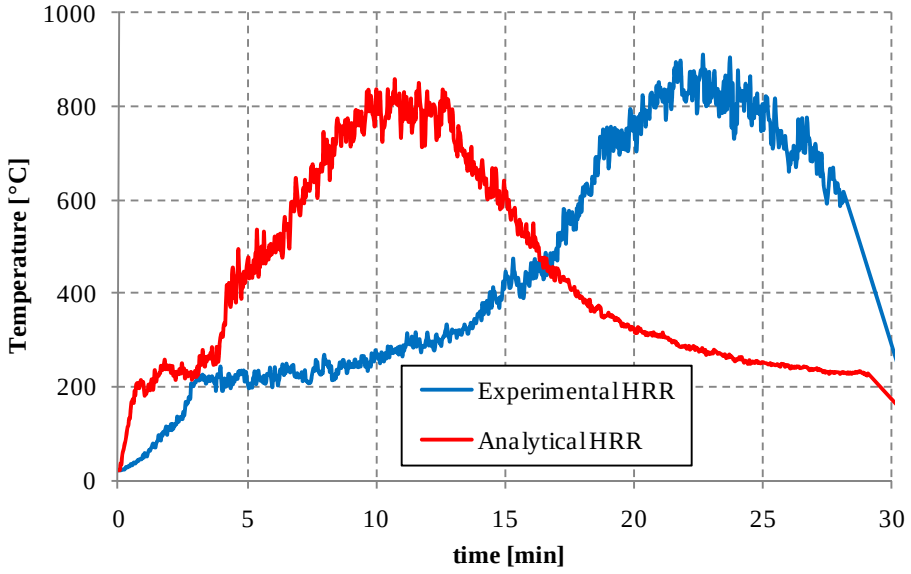
Analytical curve

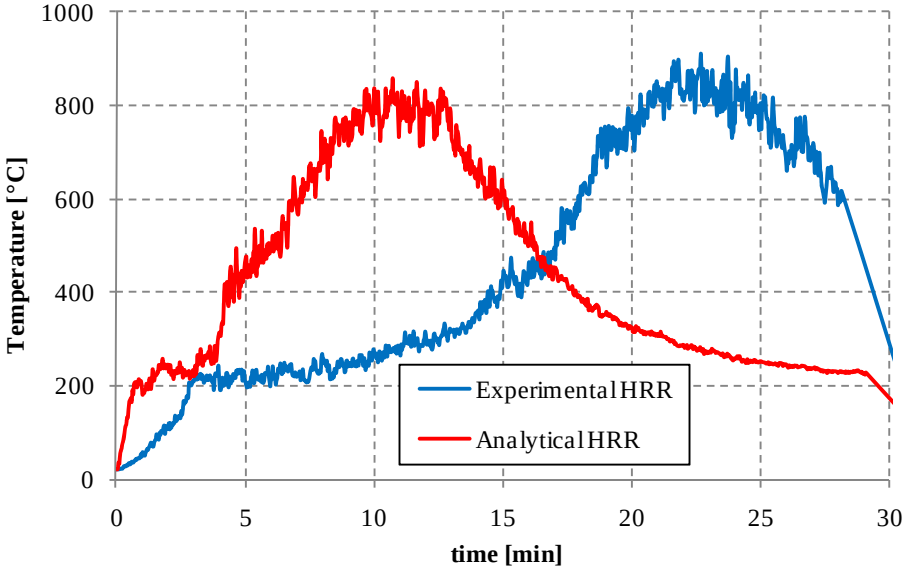
$$HRR_{s,\max} = 919 \cdot \left(1 + 2.14 h_p\right) \cdot \left(1 - 0.03 M\right)$$

where
h_p is the stack height (m),
M is the moisture (%)

Experimental curve

Averill et al., Report on Residential Fireground Field Experiments, Nist, Washington, 2010





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