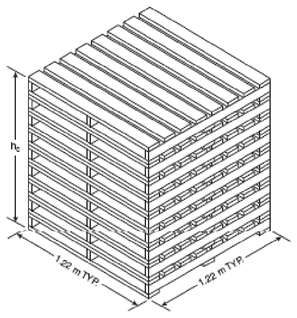
International Conference
APPLICATIONS OF STRUCTURAL FIRE ENGINEERING
Prague 29-30 April 2011

SAPIENZA
UNIVERSITÀ DI ROMA

Introduction

The quantitative assessment of the structural performance is based on a multiphysics analysis. In the process of calculating the structural behaviour, three essential models can be identified: a fire model, a heat transfer model and a structural model (Buchanan, 2002). With the wide adoption of performance-based fire safety design, CFD simulation is becoming a routine practice for obtaining the necessary fire design information.

Fuel Properties



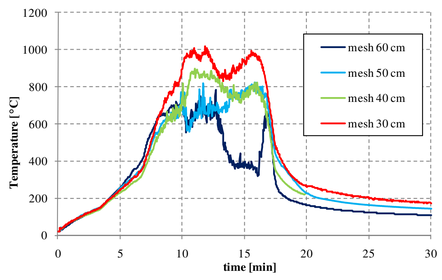
Babrauskas V., Heat Release rate. In SFPE handbook of fire protection engineering, 3rd edn, National Fire Protection Association, Quincy, MA, 2002

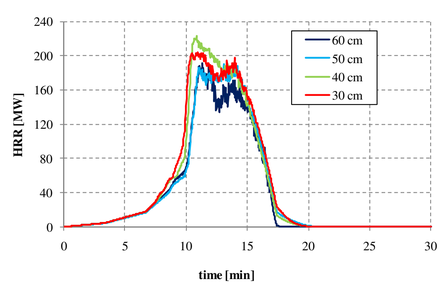
Height	3.05m
Size	1.2m x 1..2m
Weight of one pallets	15 kg
Weight of one stack of pallets	300 kg
Weight of all stacks	5400 kg
$HRR_{s,max}$	6810 Mw/m2
t_g	80 s

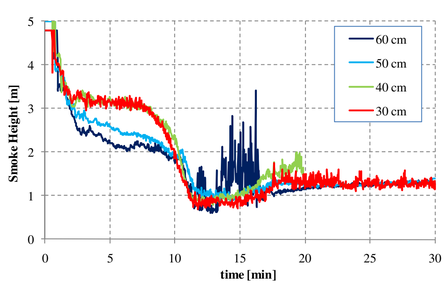
where
$HRR_{s,max}$ is the maximum of heat-release-rate per unit area,
t_g is the characteristic time of fire

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

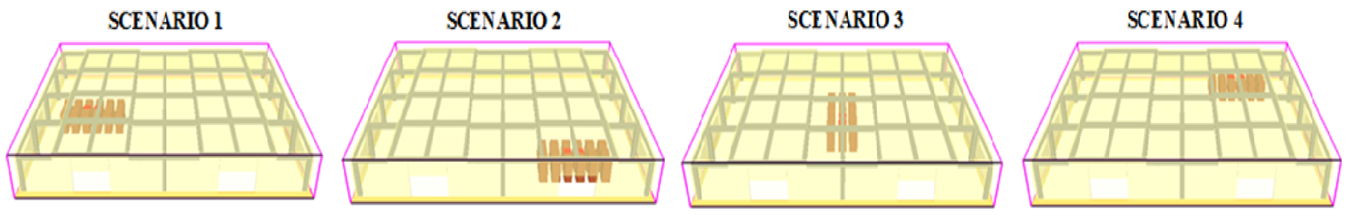


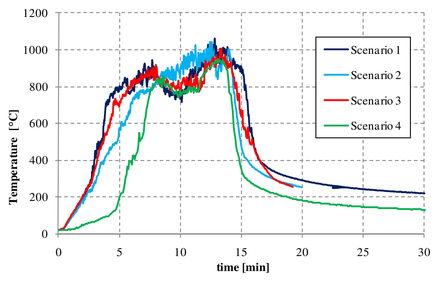


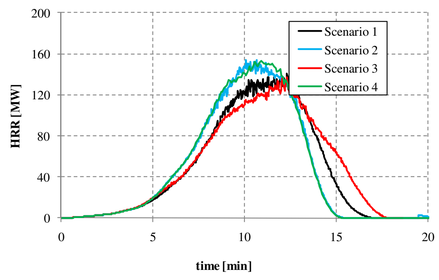


Fuel Position

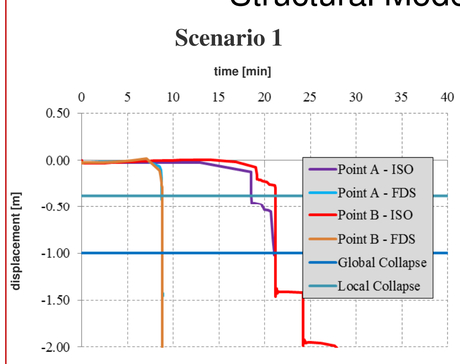
Fire Model



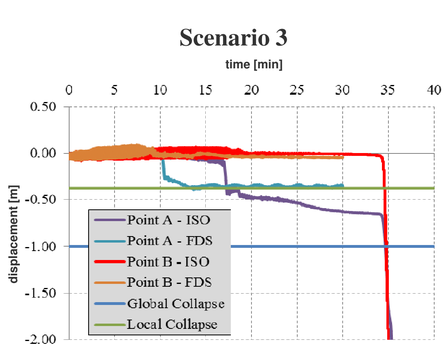


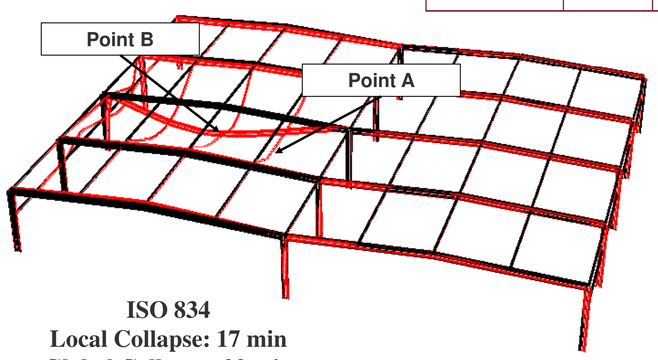


Structural Model

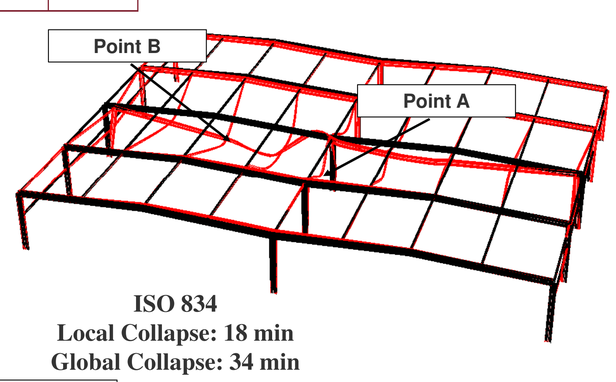


SCENARIO	Local Collapse		Global Collapse	
	ISO 834	FDS	ISO 834	FDS
1	18	11	22	11
2	15	7	18	7
3	17	12	34	--
4	15	8	18	8

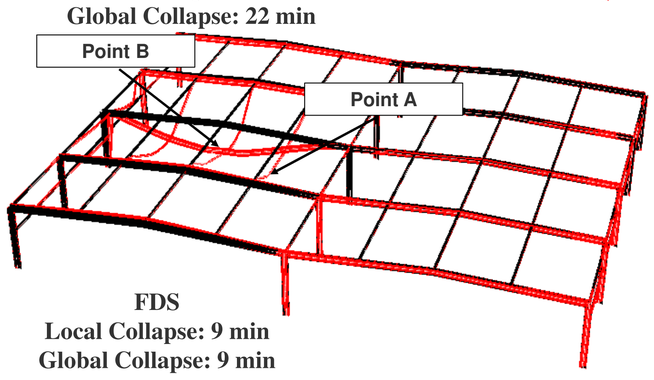




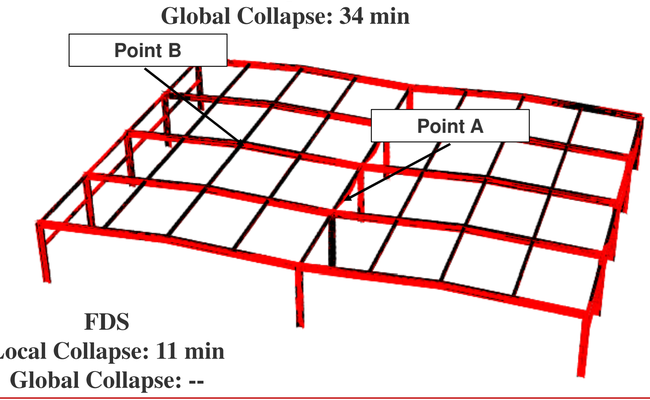
ISO 834
Local Collapse: 17 min
Global Collapse: 22 min



ISO 834
Local Collapse: 18 min
Global Collapse: 34 min



FDS
Local Collapse: 9 min
Global Collapse: 9 min



FDS
Local Collapse: 11 min
Global Collapse: --

Literature vs Experimemental HRR

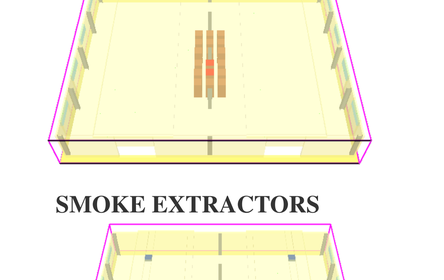
Analytical curve

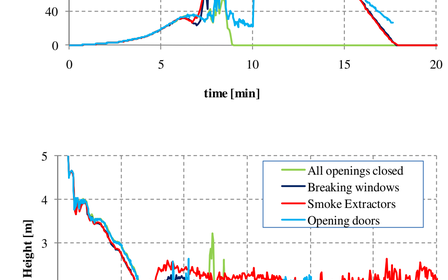
$$HRR_{s,\max} = 919 \cdot (1 + 2.14 h_p) \cdot (1 - 0.03M)$$

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

Experimental curve

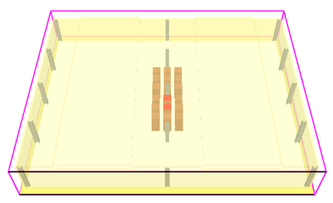
Averill et al., Report on Residential Fireground Field Experiments, Nist, Washington, 2010



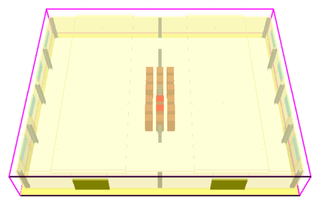


Ventilation

ALL OPENING CLOSED

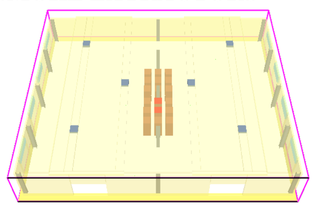


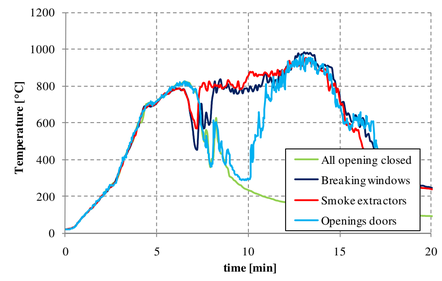
OPENING DOORS

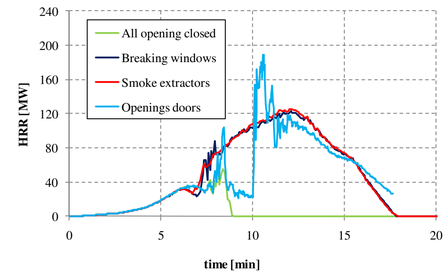


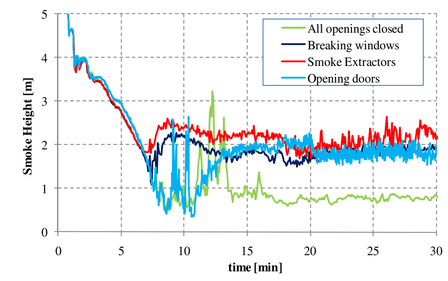
BREAKING WINDOWS

SMOKE EXTRACTORS









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 standard fire does not always lead to 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.

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

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