# LOCAFI+

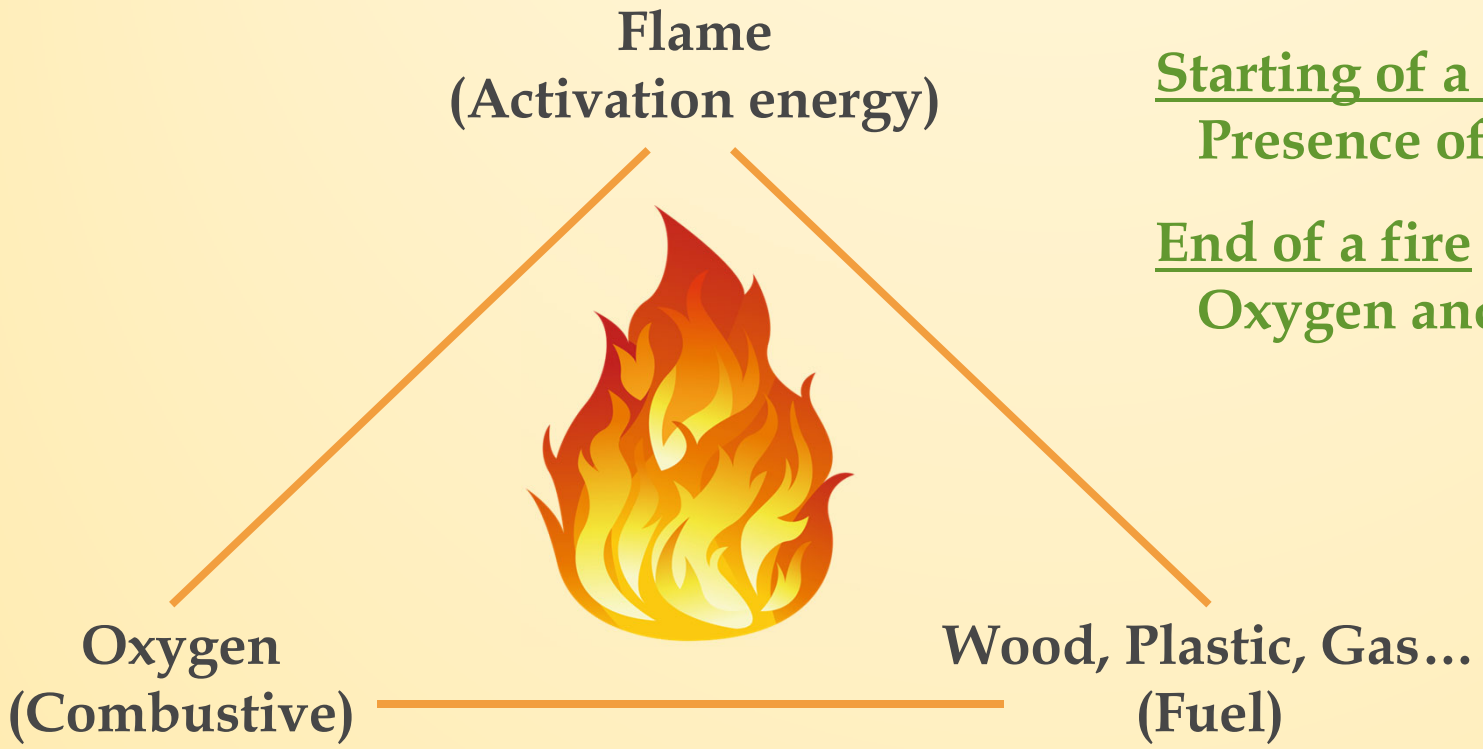
Temperature assessment of a vertical member subjected to LOCAlised FIre Dissemination

Grant Agreement n° 754072

# 2. State-of-the-art and reason for the project

# 2. State-of-the-art and reason for the project

## State-of-the-art : Development of a fire

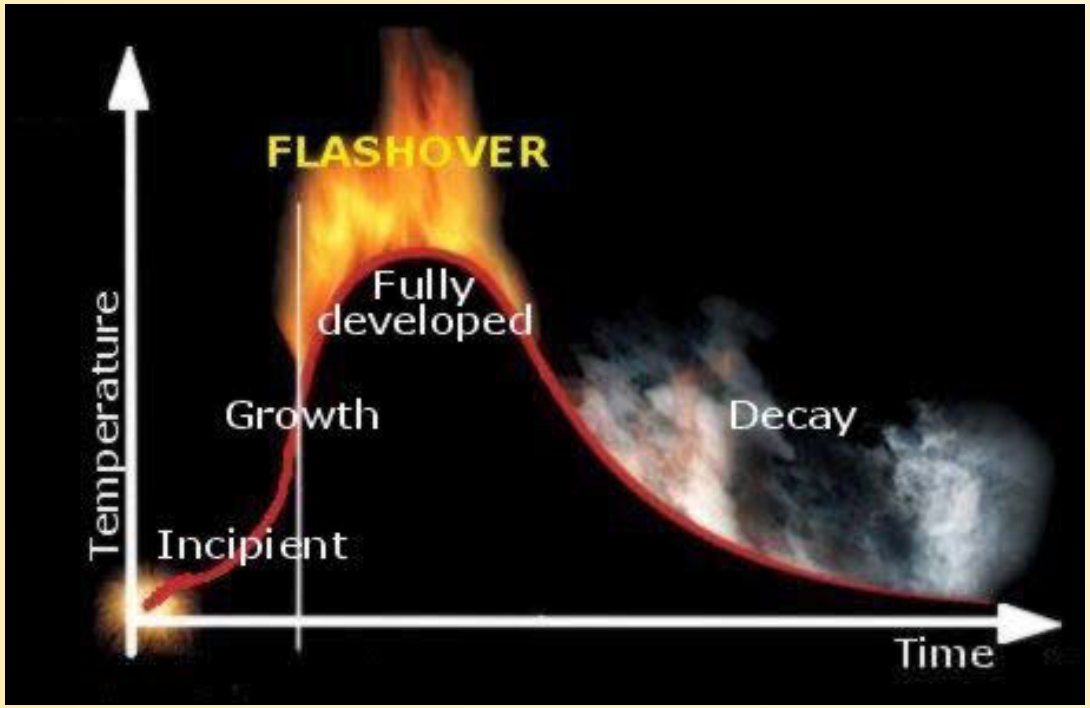



**Starting of a fire :**
Presence of 3 things simultaneously

**End of a fire :**
Oxygen and/or Fuel missing

# 2. State-of-the-art and reason for the project

## State-of-the-art : Development of a fire




Step 1 : Fire ignition (localised fire, action of firemen/sprinkler possible)

Step 2 : Development of the fire (depending on ventilation, fire load,...)

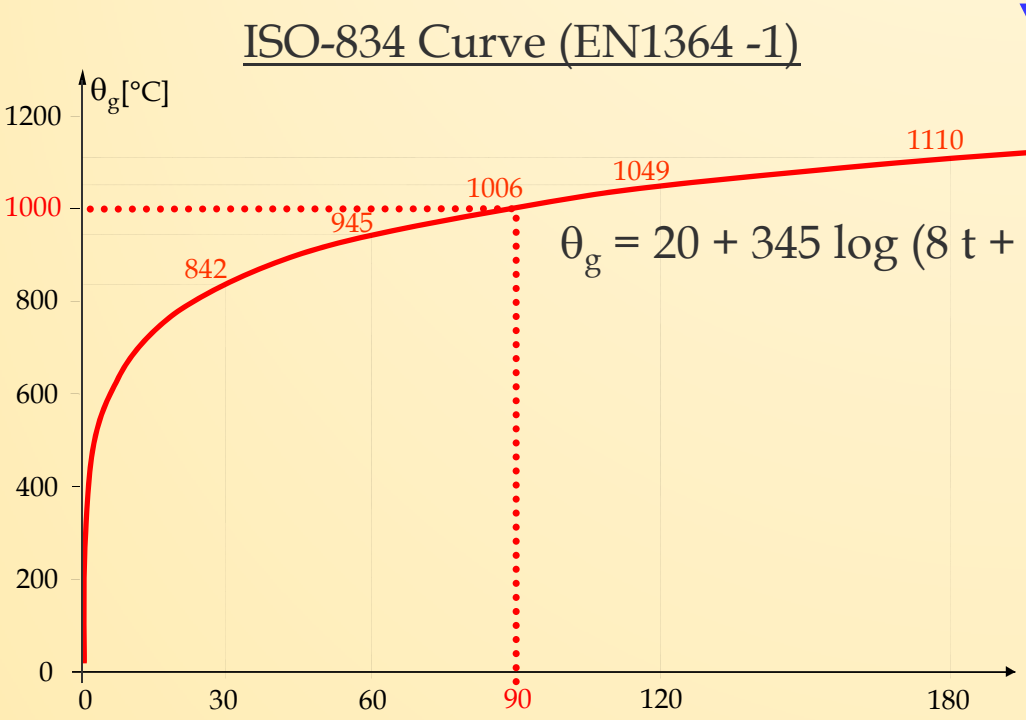
Between 2 and 3 : Flashover (from local to general)

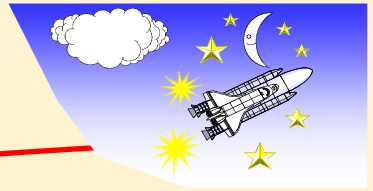
Step 3 : Fully-developped fire

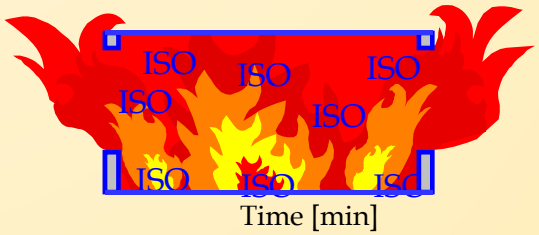
Step 4 : Decay phase (reduction of RHR due to missing fuel)

# 2. State-of-the-art and reason for the project

## State-of-the-art : Prescriptive fire curve



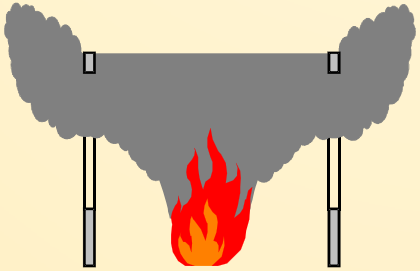



- Has to be considered in the WHOLE compartment, even if the compartment is huge
- Never goes DOWN
- Does not consider the PRE-FLASHOVER PHASE
- Does not depend on FIRE LOAD and VENTILATION CONDITIONS

# 2. State-of-the-art and reason for the project

## State-of-the-art : Performance-based fire

LOCALISED FIRE

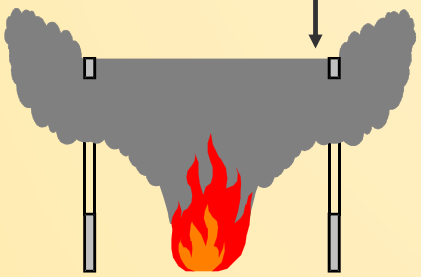


No flashover occurs

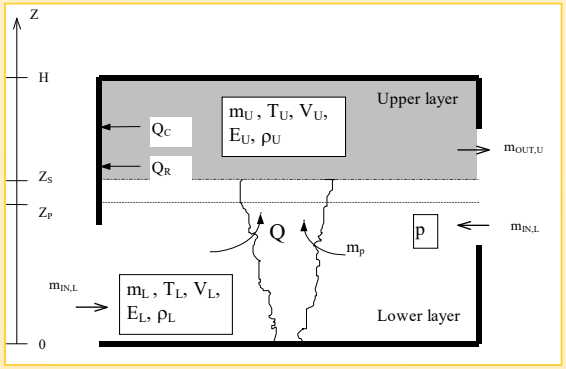
Flashover occurs

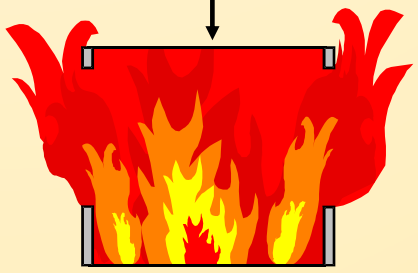
The Fire stays localised

The Fire switch to a fully engulfed fire

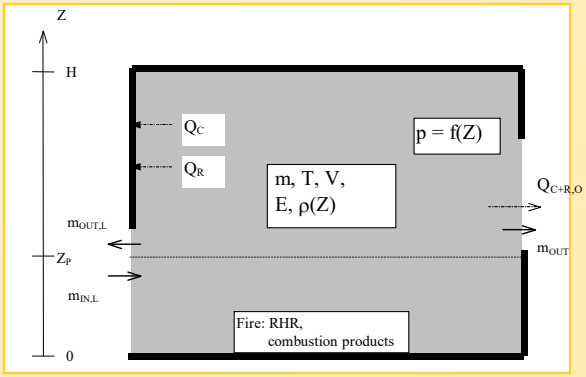


LOCALISED FIRE



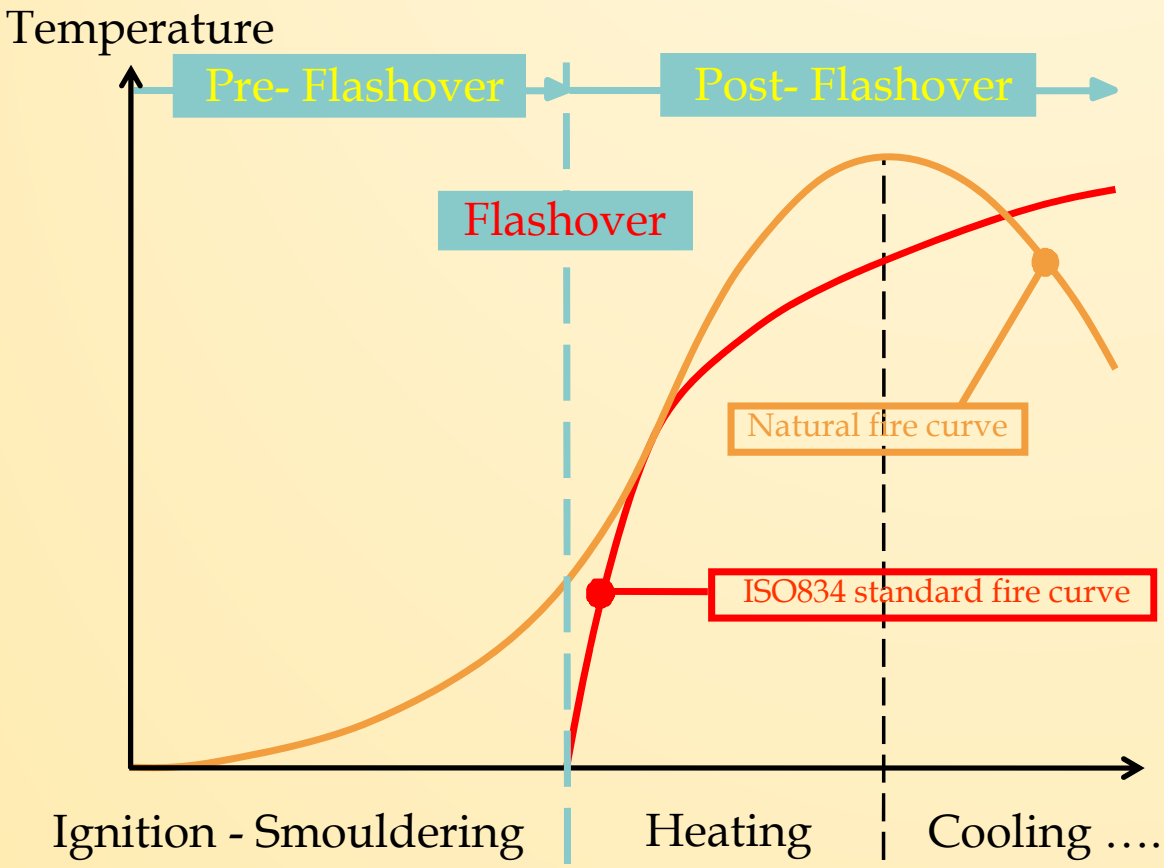



FULLY ENGULFED COMPARTMENT



# 2. State-of-the-art and reason for the project

## State-of-the-art : Performance-based fire curve




### Influencing parameters

- ✓ Boundary properties
- ✓ Ceiling height
- ✓ Opening Area

Geometry

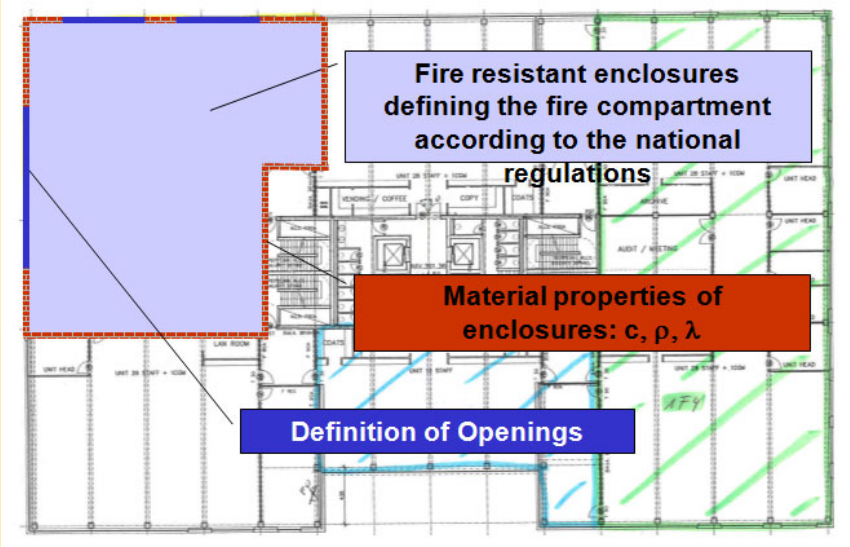
- ✓ Fire surface
- ✓ Rate of heat release

Fire

# 2. State-of-the-art and reason for the project

## State-of-the-art : Performance-based fire curve

Step 1 : Division of the building into compartments




Step 2 : Physical parameters linked to Occupancy

| Occupancy | Fire Growth Rate | $RHR_f$ [kW/m²] | Fire Load $q_{f,k}$ 80% fractile [MJ/m²] |
|---|---|---|---|
| Dwelling | Medium | 250 | 948 |
| Hospital (room) | Medium | 250 | 280 |
| Hotel (room) | Medium | 250 | 377 |
| Library | Fast | 500 | 1824 |
| Office | Medium | 250 | 511 |
| School | Medium | 250 | 347 |
| Shopping Centre | Fast | 250 | 730 |
| Theatre (movie/cinema) | Fast | 500 | 365 |
| Transport (public space) | Slow | 250 | 122 |

# 2. State-of-the-art and reason for the project

# State-of-the-art : Performance-based fire curve

Step 3 : Danger of Fire Activation

| Compartment floor area $A_f$ [$m^2$] | Danger of Fire Activation $\delta_{q1}$ | Examples of Occupancies | Danger of Fire Activation $\delta_{q2}$ |
|---|---|---|---|
| 25 | 1.10 | Art gallery, museum, swimming pool | 0.78 |
| 250 | 1.50 | Residence, hotel, office | 1.00 |
| 2500 | 1.90 | Manufactory for machinery & engines | 1.22 |
| 5000 | 2.00 | Chemical lab, painting workshop | 1.44 |
| 10000 | 2.13 | Manufactory of fireworks or paints | 1.66 |

Step 4 : Active measures

| Sprinkler | Independent Water Suppl. 0 \| 1 \| 2 | Fire Detection Heat \| Smoke | Alarm Transm. | Work Brigade | Off Site Brigade | Safe Road Access | Fire Fighting Devices | Smoke Exhaust System |
|---|---|---|---|---|---|---|---|---|
| 0.61 | 1.0 \| 0.87 \| 0.7 | 0.87 \| 0.73 | 0.87 | 0.61 | 0.78 | 0.9 \| 1.0 \|1.5 | 1.0 \| 1.5 | 1.0 \| 1.5 |

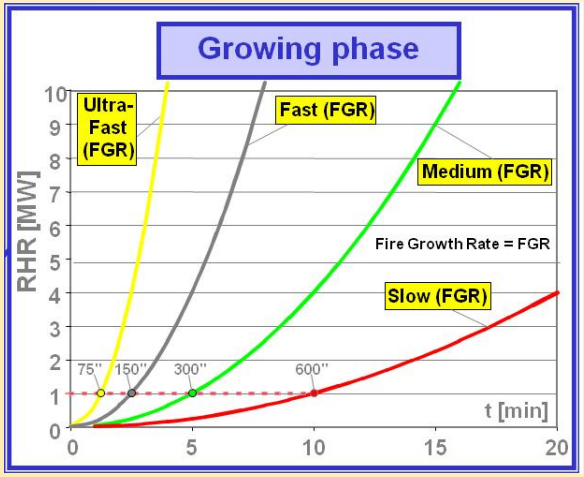
# 2. State-of-the-art and reason for the project

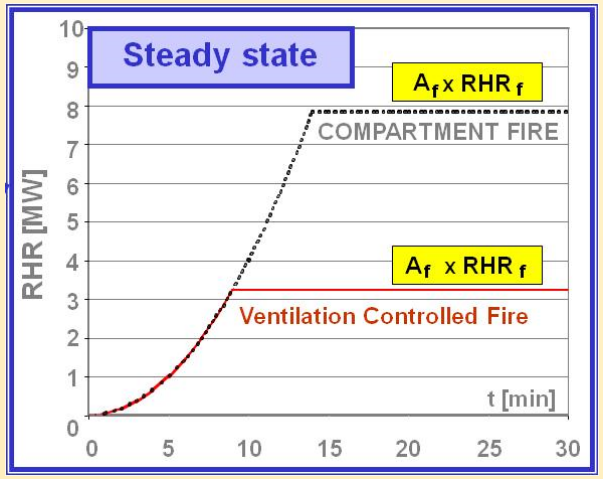
## State-of-the-art : Performance-based fire curve

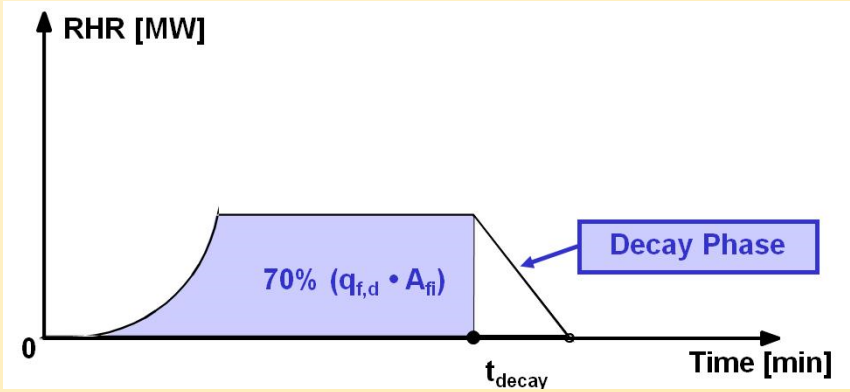
Step 5 : Design fire load

$$q_{f,d} = \delta_{q1} \cdot \delta_{q2} \cdot \prod \delta_{ni} \cdot m \cdot q_{f,k}$$

Step 6 : RHR diagram



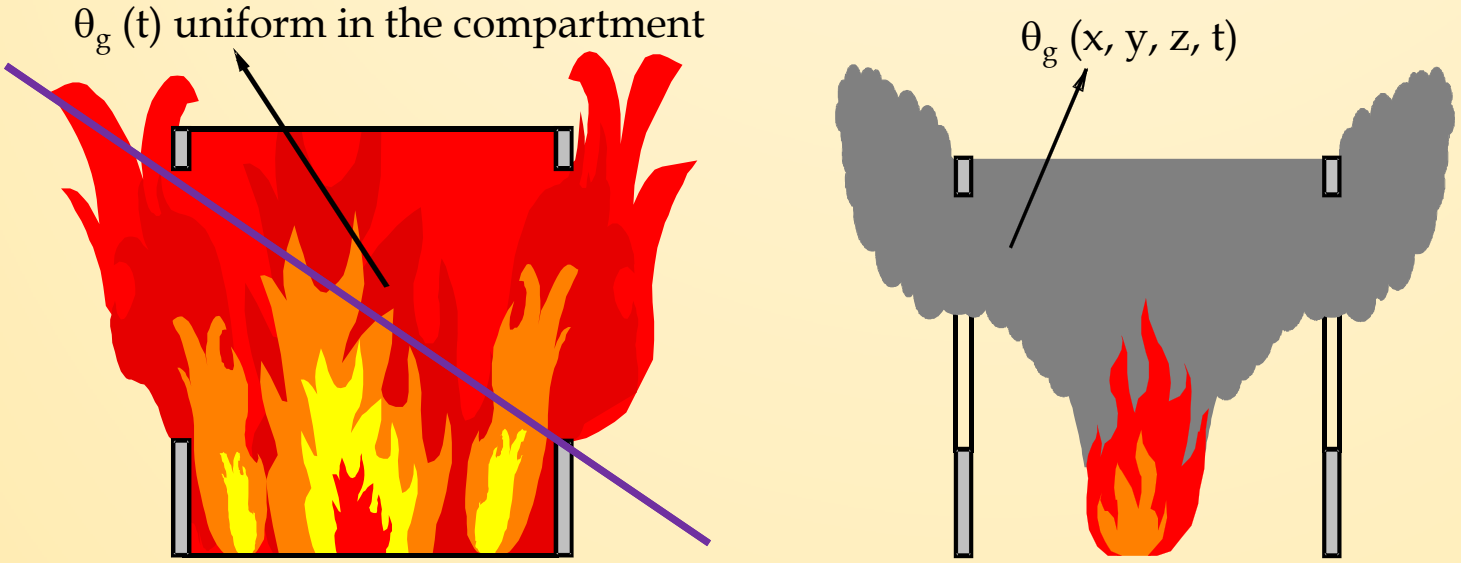



# 2. State-of-the-art and reason for the project

## State-of-the-art : Localised fire

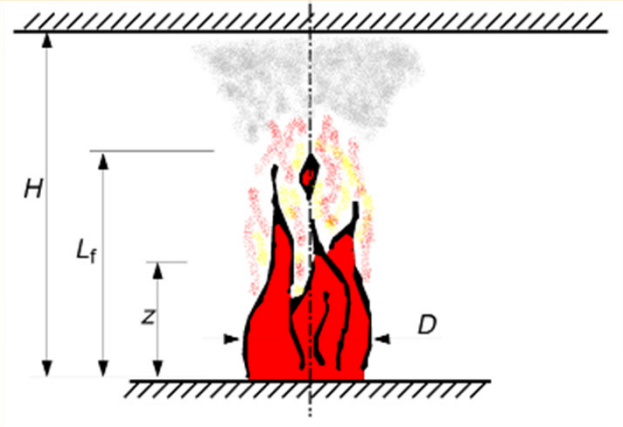
In some circumstances, the analysis of the structure under natural fire is not sufficient/realistic :
- Very large (or complex) compartment
- Ventilation controlled fire
- Fire load is localised (car park)



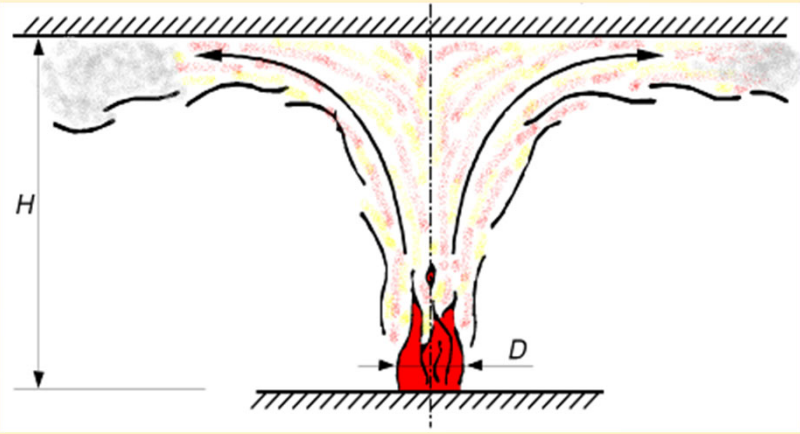
# 2. State-of-the-art and reason for the project

## State-of-the-art : Localised fire

Currently two models are available in the EN1991-1-2 Annex C to describe the effects of localised fire to the structure:




**Heskestad model**
for fire not impacting the ceiling



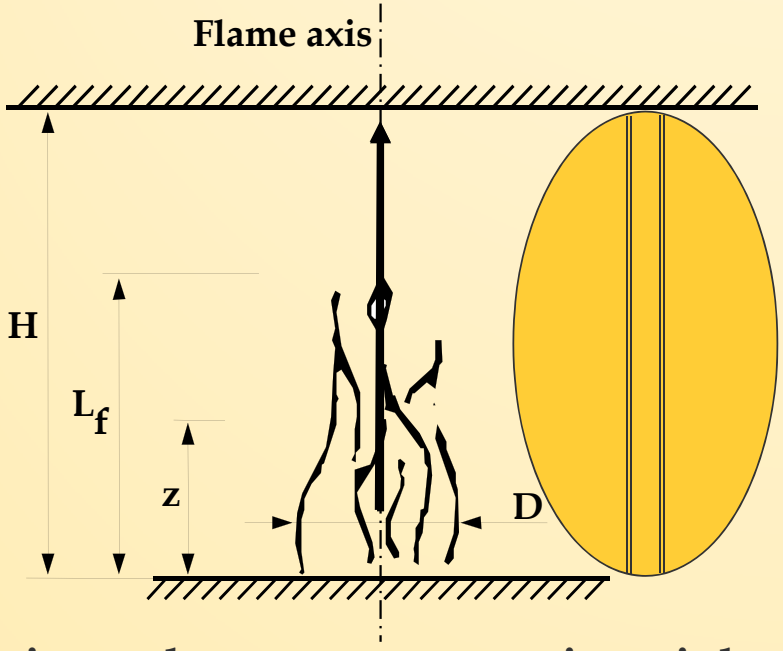

**Hasemi model**
for fire impacting the ceiling

For car parks structures, several experimental campaigns have been used to validate the ***Hasemi model*** as design tool able to reproduce with sufficient safety margin the temperature field in horizontal structural elements caused by burning cars.

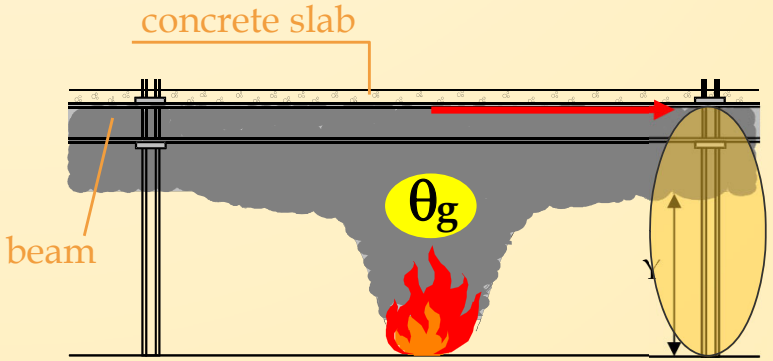
# 2. State-of-the-art and reason for the project

## Reason for the project

Annex C of EN 1991-1-2:
**Flame not impacting the ceiling**




Annex C of EN 1991-1-2:
**Flame impacting the ceiling**




Y = Height of the free zone

**In this situation, column temperature is mainly governed by radiative fluxes. But how to tackle this ?**

# 2. State-of-the-art and reason for the project

## Objectives of LOCAFI Project

- Providing scientific evidence about the thermal attack imposed on a steel column surrounded by a local fire or attacked by a local fire at a distance from the column (including verification of equations providing temperature along centreline of the source) ;
- Providing design equations that allow reproducing this thermal attack as well as temperatures induced in the column, publication of these equations and implementation in existing software (OZone, SAFIR,…) ;
- Providing rules that form the basis of the design equations in order to have them implemented in Eurocodes, which will make the models automatically accepted without any discussion by the authorities of the different Member States.