LUND UNIVERSITY

Construction fires

Dr. Stefan Svensson

Examples of activities

Fire research

- Rarely explicitly for the fire service
- Still useful from several aspects

The fire service

- Spread of smoke and fire
- Fire phenomena
- Flow rates
- PPV
- Thermal imagers
- PPE
- Tactics
- …

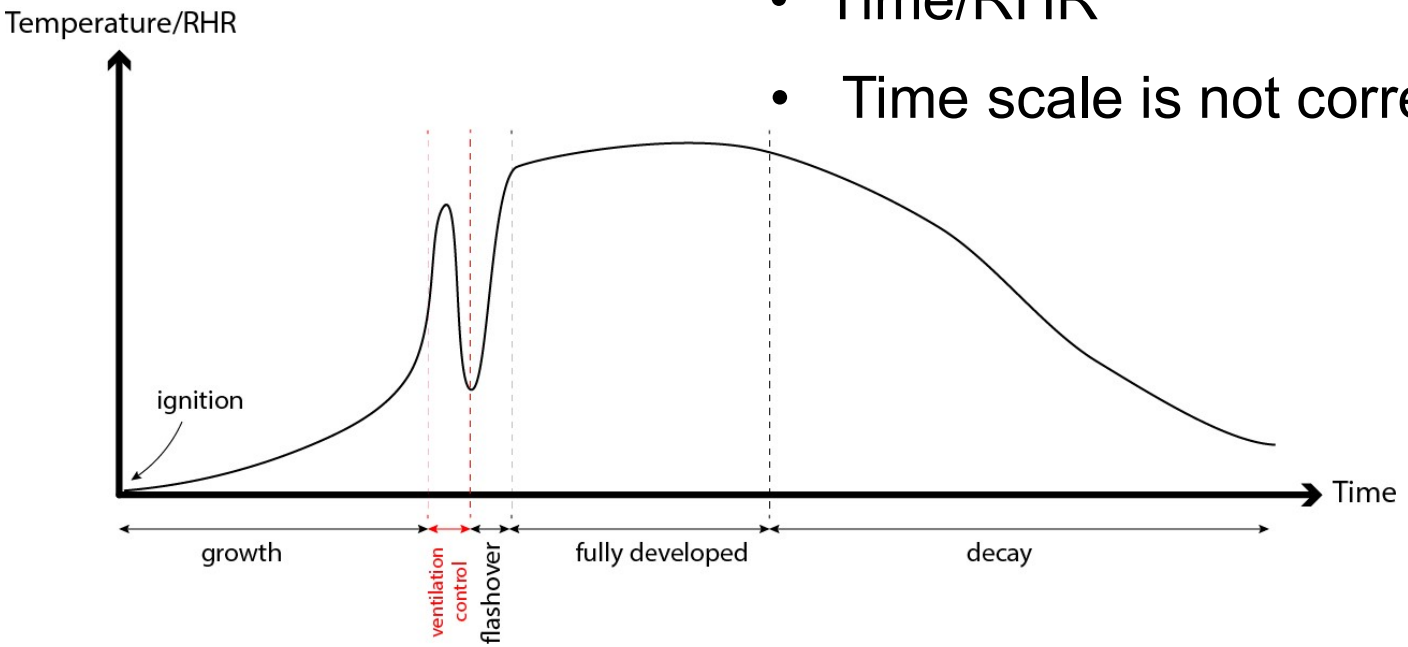
Photo: Åsa Brorsson

Compartment fires?

Valid for

- Fixed objects in the room
- Small geometries
- Restricted by walls, ceiling and floor
- Uncomplicated geometries
- Non-combustible boundaries
- Time/temperature
- Sufficient amount of fuel
- Time/RHR

- Time scale is not correct



Fire suppression

- Two opposing views:
  - large flow rates versus low flow rates
  - high pressure versus low pressure
  - straight streams versus fog nozzles

- Flow = $k \times \text{area}^n$

- If we can reach the fire,
  we can also put it out

Buildings?

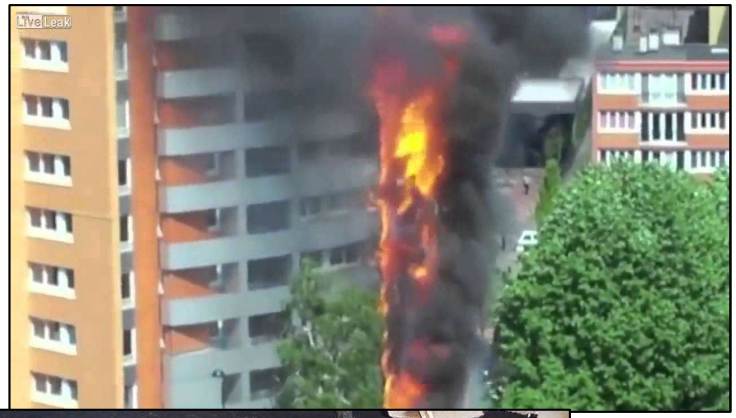
People and activities in buildings?

Design and construction of buildings?

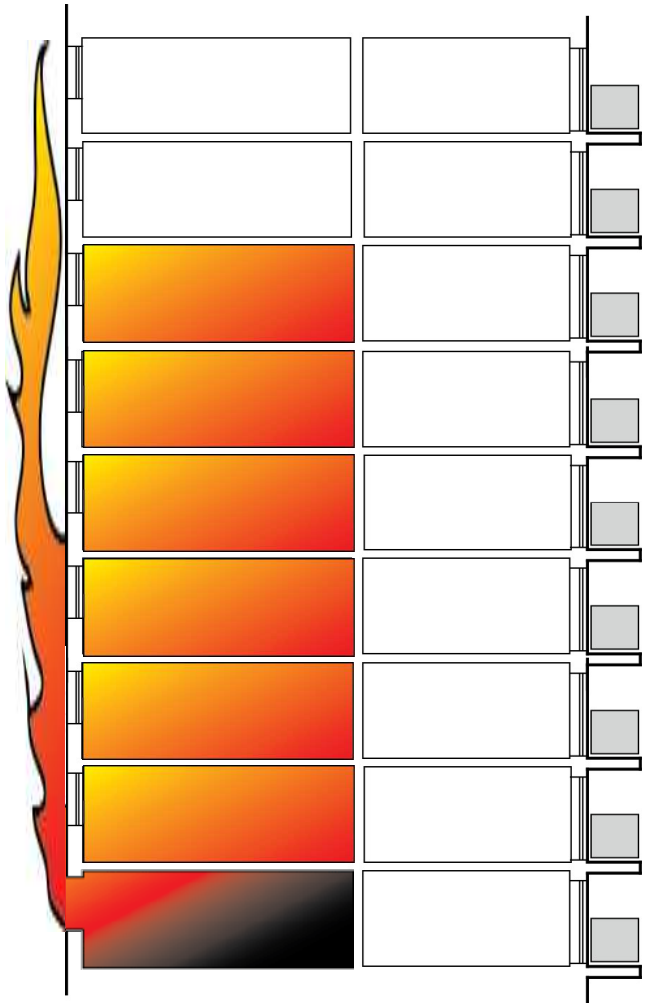
Facade fires

Construction fires

- External
  - Facades, roofs, etc.
  - Fuel controlled
  - Time is crucial?
- Internal
  - Hidden
  - Ventilation controlled
  - Time is of less importance?

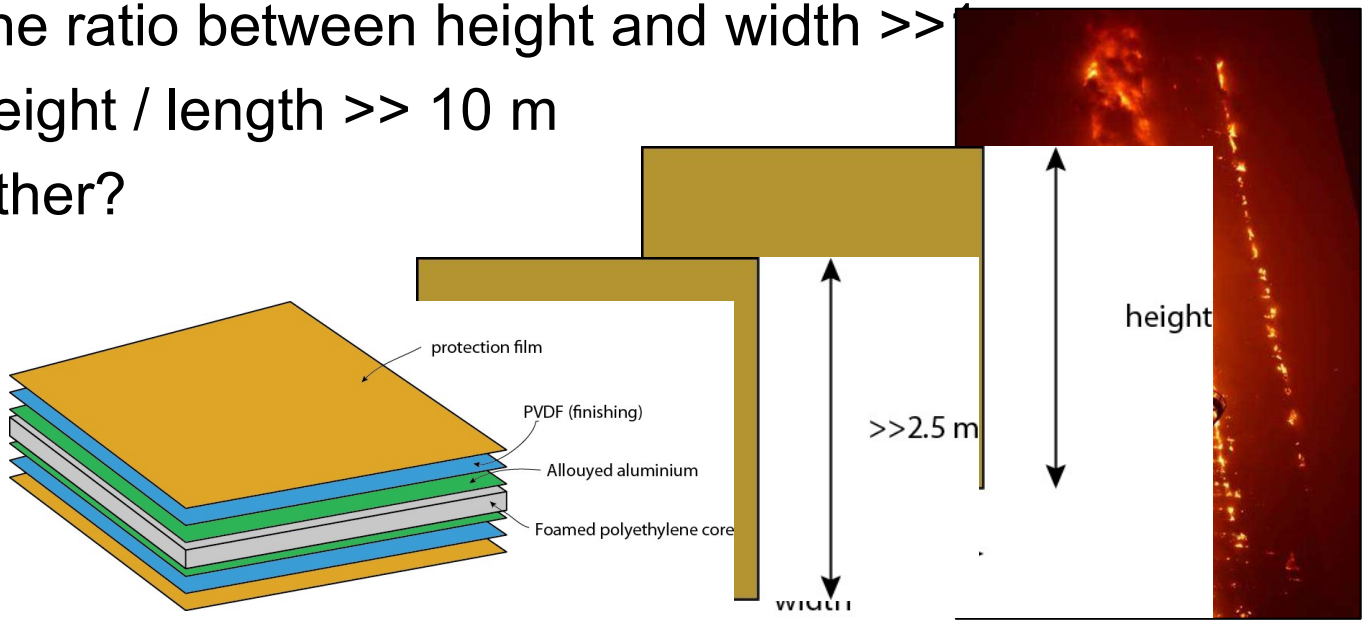


External fires: the problem

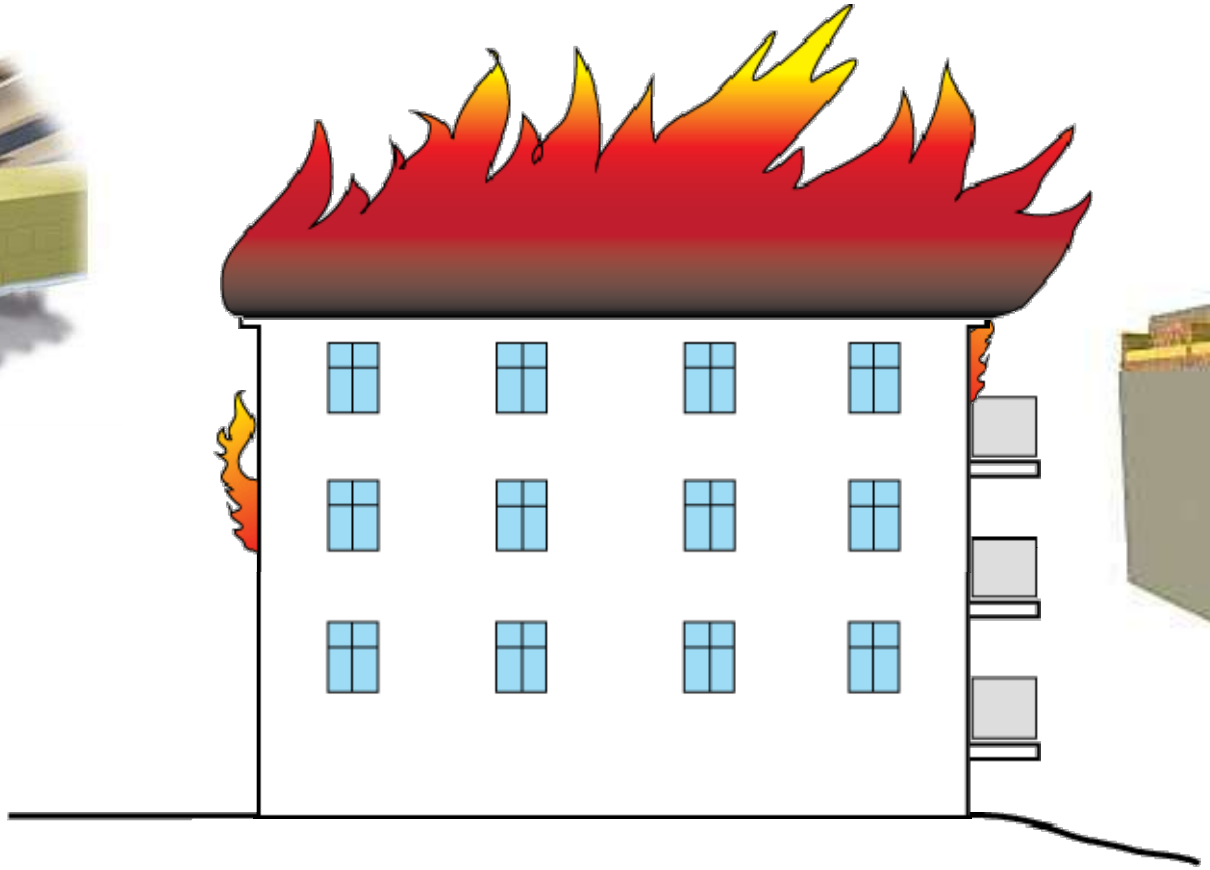


External construction fires, ”definition”

- External flammable constructions or coverings on building, including facades and roof
  - Not necessarily a dominant part of the structural element
  - Also, flammable material can be an integral part of the element
- The ratio between height and width >>
- Height / length >> 10 m
- Other?

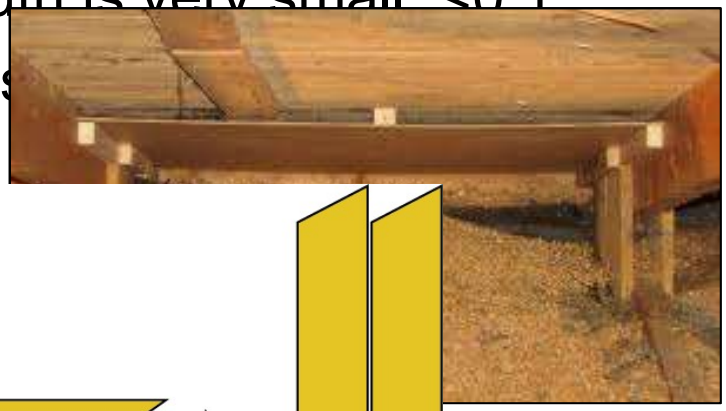


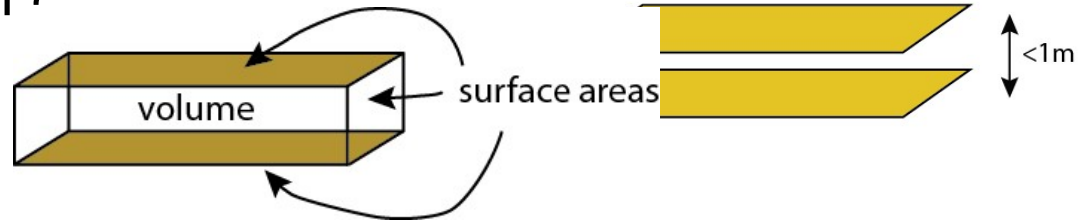
Internal fires: the problem



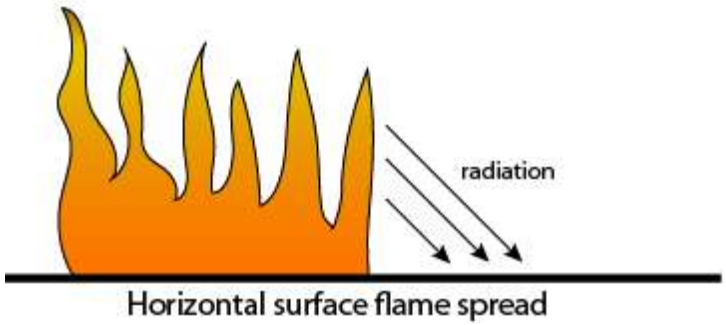
Internal construction fires, ”definition”

- Flammable
  - Not necessarily a dominant part of the structural element/volume
  - Flammable material can be an integral part of the element/volume
- Internal spaces/volumes with limited access
- Ratio between height and length/width is very small, <0.1
- Distance between opposing surfaces small, <1m
- Ratio between area of surr the space is very large, >1(
- Other?





Spread of fire, orientation



Spread of fire, opposing surfaces

- Radiation between surfaces
- Vertical surfaces = “chimney”
  - Creating pressure differential
  - Increased velocity

Spread of fire

	Vertical	Horizontal
External	Growths exponentially Fast flame spread High heat flux Large convection Visible	Slow (?) growth Slow flame spread Visible
Internal	Growths exponentially High velocities in flowing gases Non-visible	Slow (?) growth Low heat flux Large convection Non-visible

Consequences

External construction fires

- Flames on vertical surfaces accelerates exponentially
- Several apartments at different levels might get involved

Internal construction fires

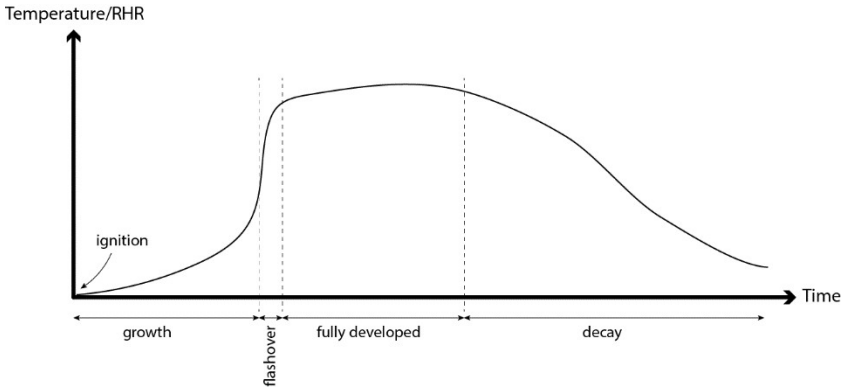
- Fire may or may not accelerate exponentially
- Opposing surfaces increases heat flux to surfaces
- Small volumes collect more hot gases, which increases heat flux to surfaces
- Increased heat flux to surfaces increases flame spread
- More fire gases limits oxygen content, which limits flame spread
- High heat in volume increases production of (flammable) fire gases
- Large height increases pressure differential (unless the volume is closed)
- Increased pressure differential, increases flow rate, thus increasing flame spread (unless the volume is closed)

Fire service problems

- Accessing fire on high façades (hard to reach)
  - External suppression from inside
  - Firefighting at several levels simultaneously
- High levels of heat flux from external fires
  - Hard to get close
- Accessing fire in a hidden volume (hard to find)
  - Application of water ”in the dark”
- Ventilation controlled fires in small volumes
  - Flame spread “in the dark”
  - Sudden changes?
  - Slower fire development?
  - Smoldering fires: heat or smoke not necessarily easily detected?
- Faster development of the fire (internal/external)
  - Large pressure differentials
  - Flammable constructions

Above all:

Commonly used fire behavior models no longer valid



Commonly used fire suppression models no longer valid

Conclusions

- Content fires (compartment fires) are easy to fight
- Façade fires are challenging
- Hidden fires are hidden

- Requires different approach

- Possibly an increasing problem, due to development of building products and building technology

- Preparing (educate/train) the fire service for tackling the problem

Photo: Åsa Brorsson

Thank you very much!

stefan.svensson@brand.lth.se


STAND BACK!
THERE'S SCIENCE IN THIS SHIT!