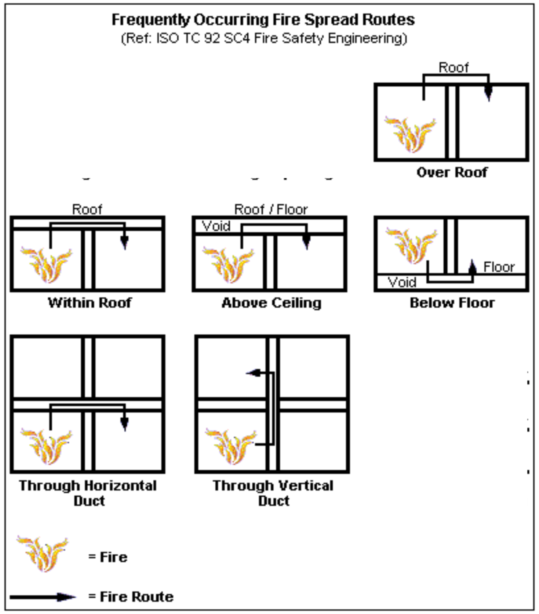
FIRE SAFETY GROUP

FIRE SAFETY OF CAVITY SPACES

- **Fire spread in cavity spaces may lead to severe consequences**
    - Multi-victim incidents, e.g., the Düsseldorf Airport catastrophe
    - High financial losses, e.g., 1998 one cavity fire amounted to close to 10 % of the total losses that year in Finland
- **Difficult to detect and extinguish**

CAVITIES WITH ELEVATED FIRE HAZARDS

- False ceilings
- Floor voids
- Roof cavities & attics
- Wall cavities (inner partitions & facades)
- Double skin facades (potentially)



RESEARCH AT VTT

- **Finnish Project "Fire Safety of Cavity Spaces"**
  - 1. Characteristics of Fires in Cavity Spaces
  - 2. Prevention of Fire Spread in Cavity Spaces
  - 3. Extinguishing Fires in Cavity Spaces
- **Part 1 completed, results published in Finnish (thus far)**
  - J. Hietaniemi, T. Hakkarainen, J. Huhta, T. Korhonen, J. Siiskonen & J. Vaari. 2002. Fire Safety of Cavity Spaces: Experimental and Simulation Study of Fires in Cavity Spaces. VTT Research Notes no. 2128, in print. (in Finnish)
- **Part 2: going on**
- **Part 3: to be started in summer 2002**
- **Project will be completed in the end of 2002**
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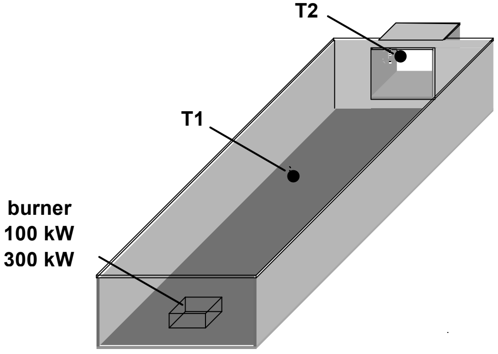
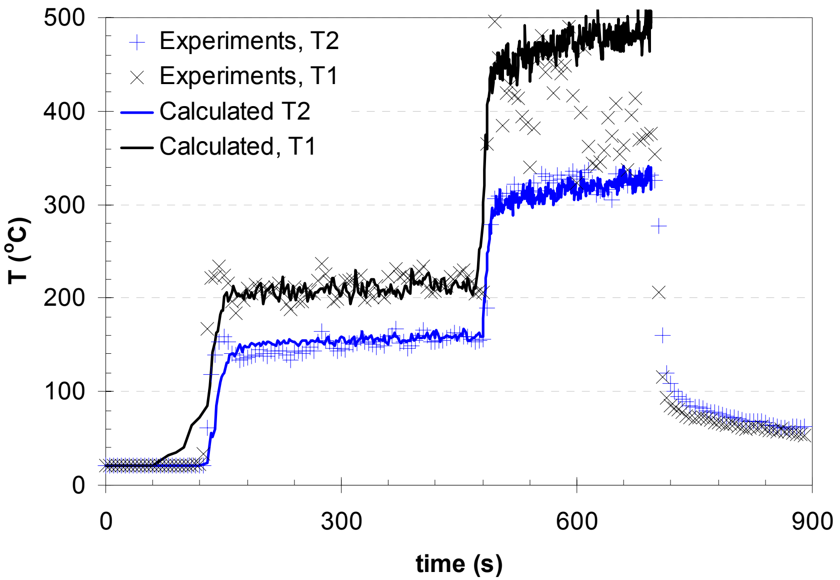
EXPERIMENTAL AND SIMULATION STUDY OF FIRES IN CAVITY SPACES

- **Quantitative approach to the problem**
  - Simulations using fire models of different levels
    - from simple analytical models to FDS
  - Experiments to **validate** the computational approaches (large and small scale)
- **Models must reproduce the experimental flame spread**
  a) with sufficient accuracy and
  b) with sensible input parameters
- **Factors measured & modelled: HRR and flame spread rate**
- **"Checked" models can be used to assess flame spread in spaces different from those used in the experiments**
  - Note: Caution must be excercised not to extrapolate too far (validity applies only for "sufficiently similar" spaces and materals).
- **NB:** Studies done in 1999 and 2001 => FDS1 used

CAVITY WITH NON-COMBUSTIBLE WALLS AND NO FIRE LOAD

- **6 m, 1.2 m & 0.6 m (L,W & H)**
- **Burner 100 kW and 300 kW**
- **Excellent agreement between measured and calculated results**
    - measured T1 at ca. 600 s: too low readings due to bending of the cavity ceiling





CAVITIES WITH WOOD AS THE DOMINANT FIRE LOAD

- Cavities such as roof cavities & attics
- Spruce boards, 6 x 1 x 0.5 m^3, ign. 50 kW, vertical smoke exhaust shaft at read end

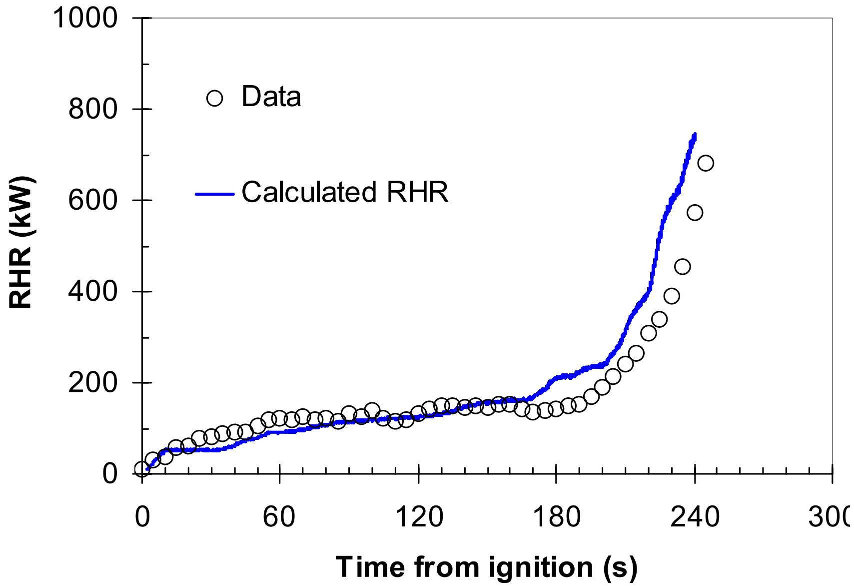
before ignition

ca. 4 min from ignition

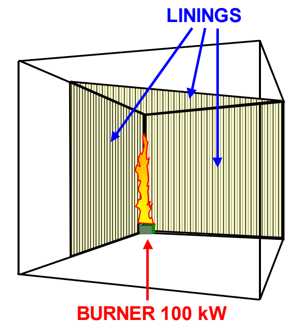
- Very fast flame spread after about 3 min delay after ignition
  - hot gases (600 C flame front): up to 7-8 m/min
  - very fast HRR growth rate (growth time 75 s)

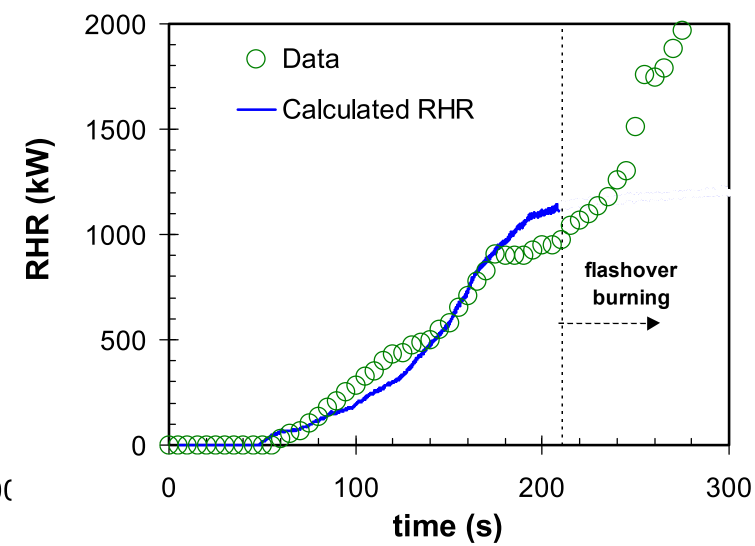
FIRES IN WOOD CAVITIES: MODEL VALIDITY

- Measured and calculated (FDS1) HRR
- Good agreement



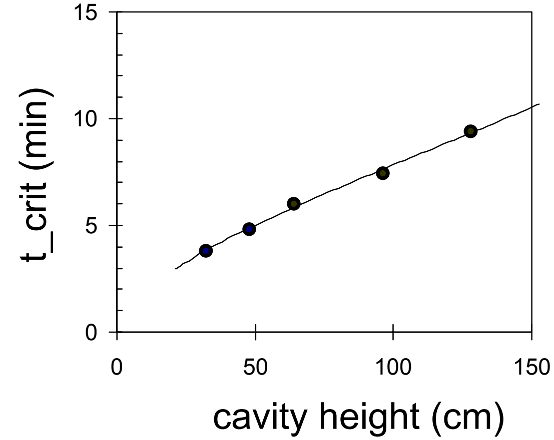
- Agreement is fine, but is it coincidental…?
- Further confirmation: an RC test with partial wood lining
- Good agreement





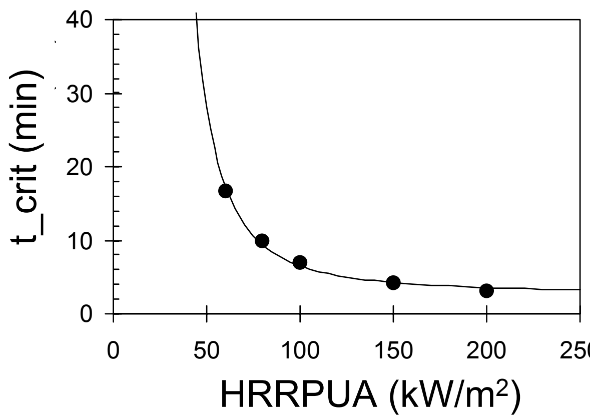
WOOD CAVITIES: EXAMPLES OF THE USE OF THE MODEL

- **Influence of the cavity size** (no flow through the cavity)
    - t_crit = time delay to onset of catastropic fire spread
    - here: cavity height

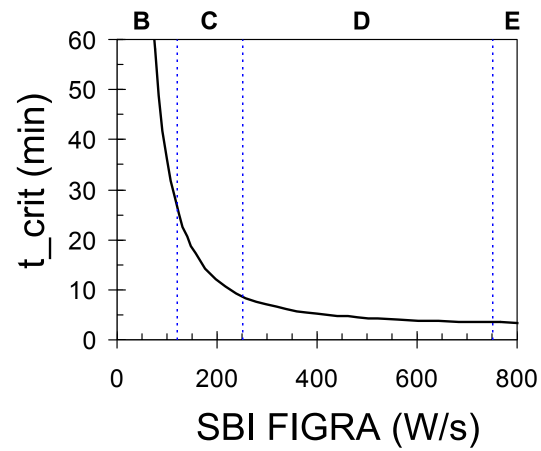


- **Influence of fire load flammability**

in terms of kW/m^2

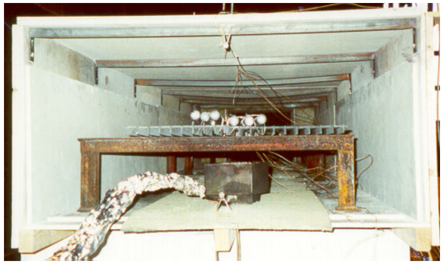


in terms of euroclasses



CAVITIES WITH CABLES AS THE DOMINANT FIRE LOAD

- False/suspended ceilings, floor voids
- XLPE sheath & insulations (no PVC for practical and safty reasons!) , 6 x 1.2 x 0.6 m^3, ign. 50 kW, vertical smoke exhaust shaft at read end



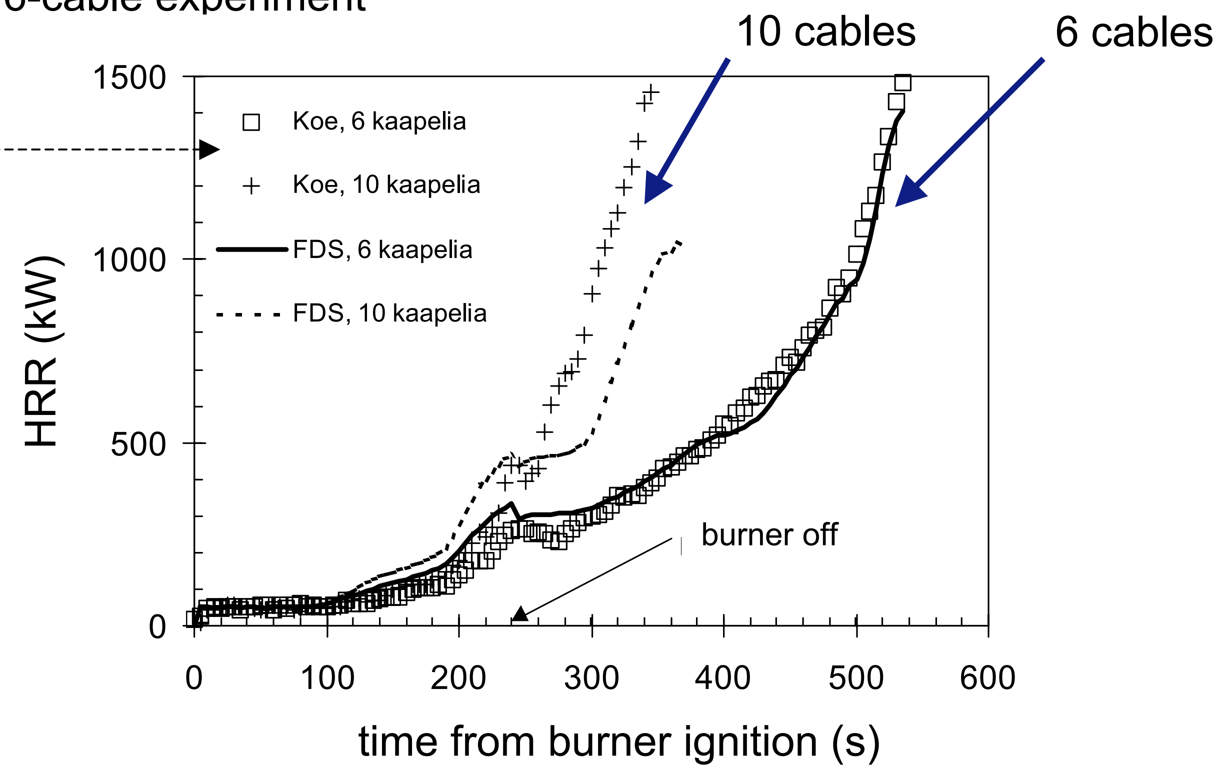
- Very fast flame spread after about 5-8 min delay after ignition (depending on fire load)
  - hot gases (600 C flame front): up to 2-4 m/min
  - fast HRR growth rate (growth time 150 s)

CABLE FIRES IN CAVITIES: MODEL VALIDITY

- Measured and calculated (FDS1) HRR
- Model "tuning" with the results of 6-cable experiment
- Check by comparison to the 10-cable experiment HRR

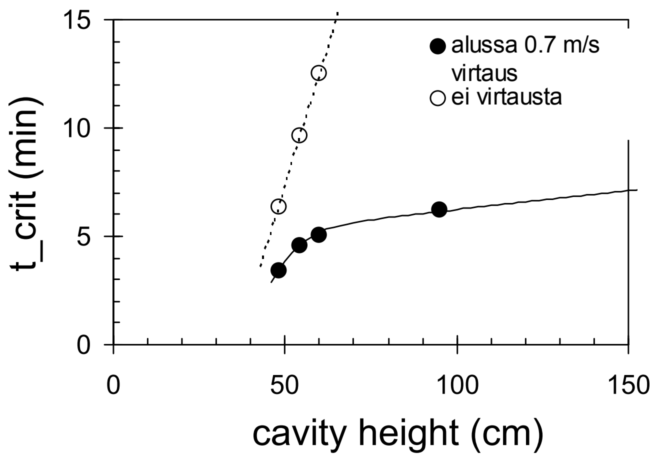
Translations:

koe = experiment
kaapelia = cables



CABLE FIRES IN CAVITIES: EXAMPLES OF THE USE OF THE MODEL

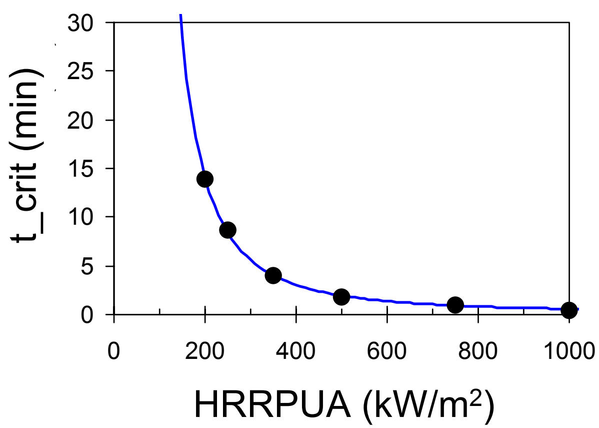
- **Influence of the cavity size & flow conditions in the cavity**



no flow

flow 0.7 m/s

- **Influence of fire load flammability**



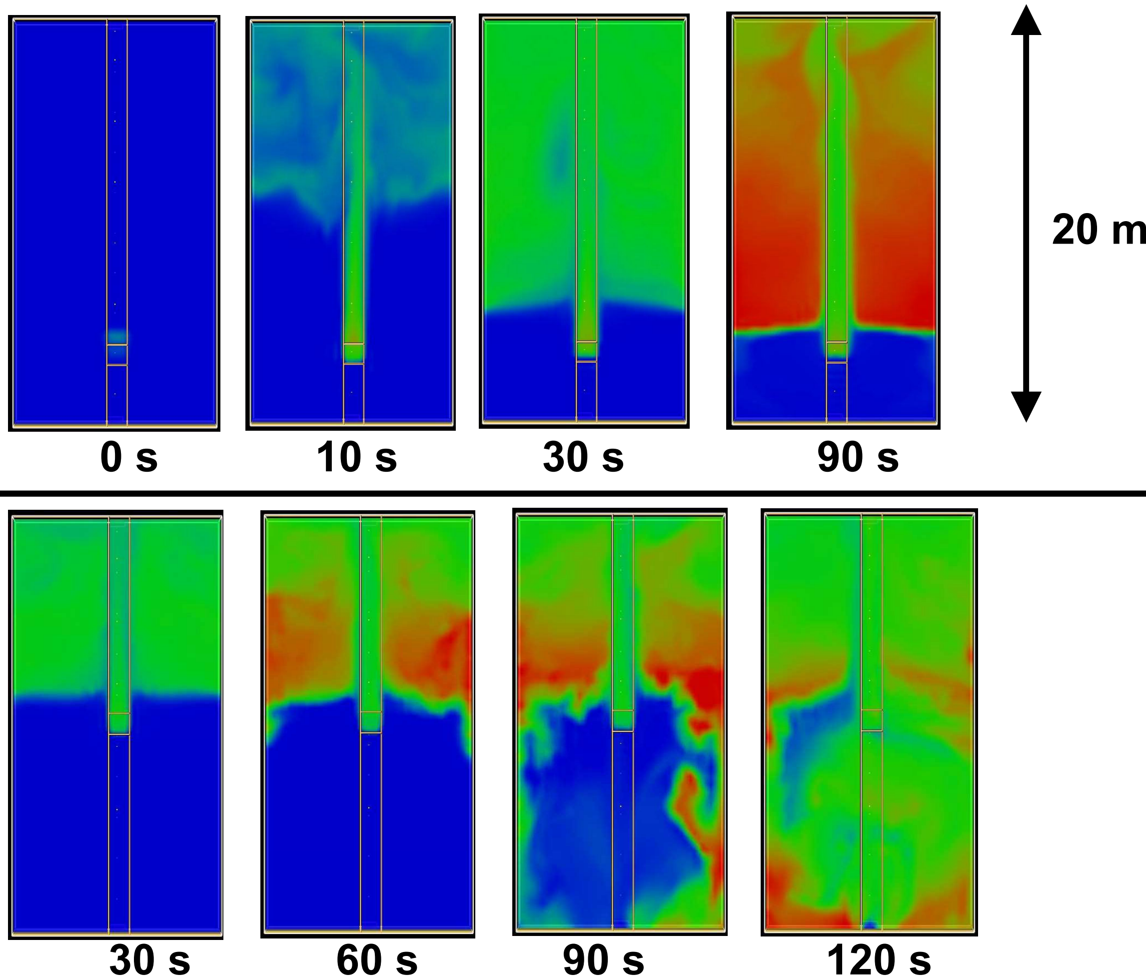
in terms of kW/m^2

DOUBLE SKIN FACADES

- **Possibility of smoke filling below the room of fire origin (here FDS2)**

Window at 3 m: "normal" smoke filling

Window at 10 m: smoke filling down to the bottom



frontal view of the façade, cavity depth 50 cm

CONCLUDING REMARKS

- Substantiated by comparison to experiments, modern flame spread models offer a viable tool to survey fire hazards
  - Model limitations must be acknowledged
    e.g. ventilation limitations (FDS1), grid dependence, etc.
  - Correctness of extrapolations beyond the “region of validity” must always be given a critical consideration
- At VTT, fires in cavities have been successfully characterised via combining experiments and fire simulation
- The results enable identification of critical factors and point out ways to prevent and alleviate the hazards
- Work going on to establish practical means to improve fire safety of cavity spaces