Meacham Associates

HOLIFAS - A HOLISTIC APPROACH FOR FIRE SAFETY REQUIREMENTS AND DESIGN OF FACADE SYSTEMS

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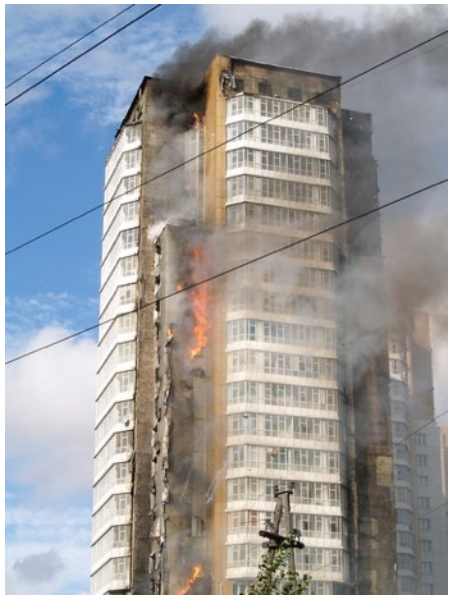
- Objectives
- System and holistic view
- Different façade systems
- Technical holistic aspects
- Socio-technical system (STS) aspects
- Fire safety determination
  - Prescriptive
  - Alternative approaches
- Conclusions
- Future Research

Background

- Several façade fires worldwide
  - Dubai
  - Azerbaijan
  - Atlantic City, US
  - Roubaix, France
  - Lacross building, Melbourne
  - Grenfell Fire UK

Atlantic City, USA

http://www.fireengineering.com/articles/2010/05/modern-building-materials-are-factors-in-atlantic-city-fires.html



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Grenfell

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Objectives

- Fire safety requirements on external façades systems through a technical holistic approach.
- Holistic approach to the building regulatory process, from a socio-technical systems perspective.
- Research gaps and research questions which need to be addressed in order to safeguard the occupant and fire safety of modern and renovated buildings

Set-up of the project

- WP 1 – Collection of façade systems
- WP 2 – Technical Requirements
- WP 3 – Socio-technical system considerations and regulatory system comparisons
- WP 4 – Reporting, Dissemination and Management

Methods

- Literature reviews
- Surveys (e.g. market survey by BRIAB before the project)
- Interviews with experts
- Expert meetings and discussions (SBU, Swedish Building University)

Why more system and holistic thinking in fire testing?

- Traditionally based on standardised tests at international level and regional level.
- Quite often “scenario” defined whether it is a reaction to fire test or a fire resistance test.
- However todays fire risks are more complex and needs different view angles to tackle the problem
- An overall view is necessary which is a holistic approach

Why more system and holistic thinking in fire testing?

- A typical example are façade systems
  - Different type of systems
  - Different type of other technical properties
  - Socio-technical aspects
  - Different type of fires
  - Different fire risks
  - Different type of fire test methods

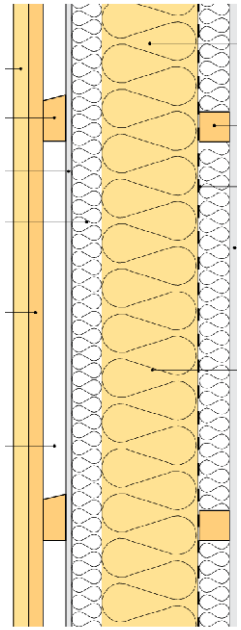
Different Systems – Complexity - Results

- Possible classifications of façades systems based on market survey, literature study, meetings and interviews with experts.
- A clear definition will be needed as it differs in the different areas!
- Results : A myriad of different systems (see following slides)

Different Systems - Low Ventilated/Cavity façade systems

Brick veneer

Picture Lund University

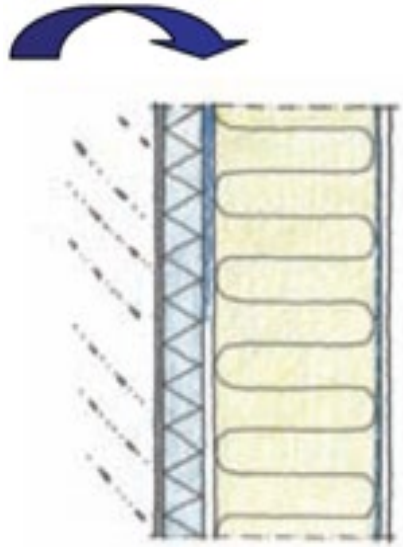


Wooden construction

Picture Träguiden (reproduced)

Complexity – Rendered systems

ETICS



Pictures Lund University

Complexity – Panel systems

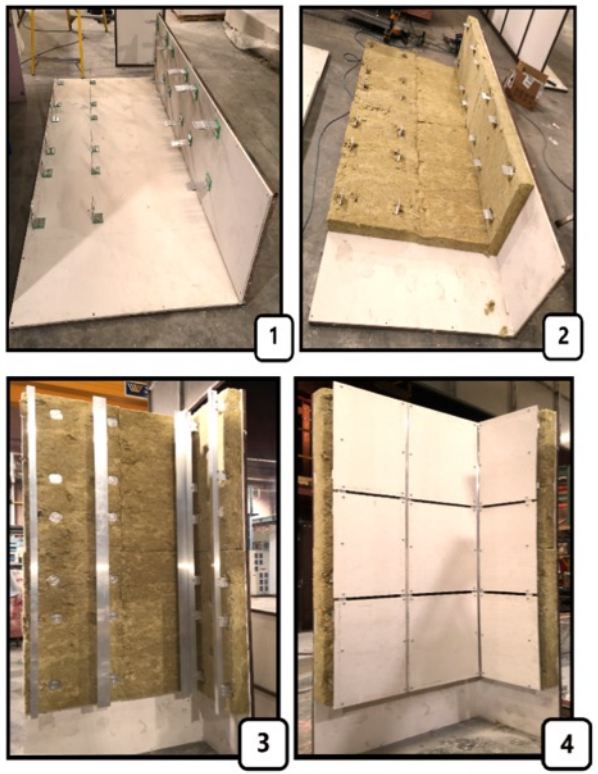
Picture Lund University

Complexity – Curtain wall claddings

Picture courtesy Designing Buildings Wiki, ICE et al. 2019

Complexity – Rain screen claddings

Picture courtesy ID 44710574 © Antikainen | Dreamstime.com



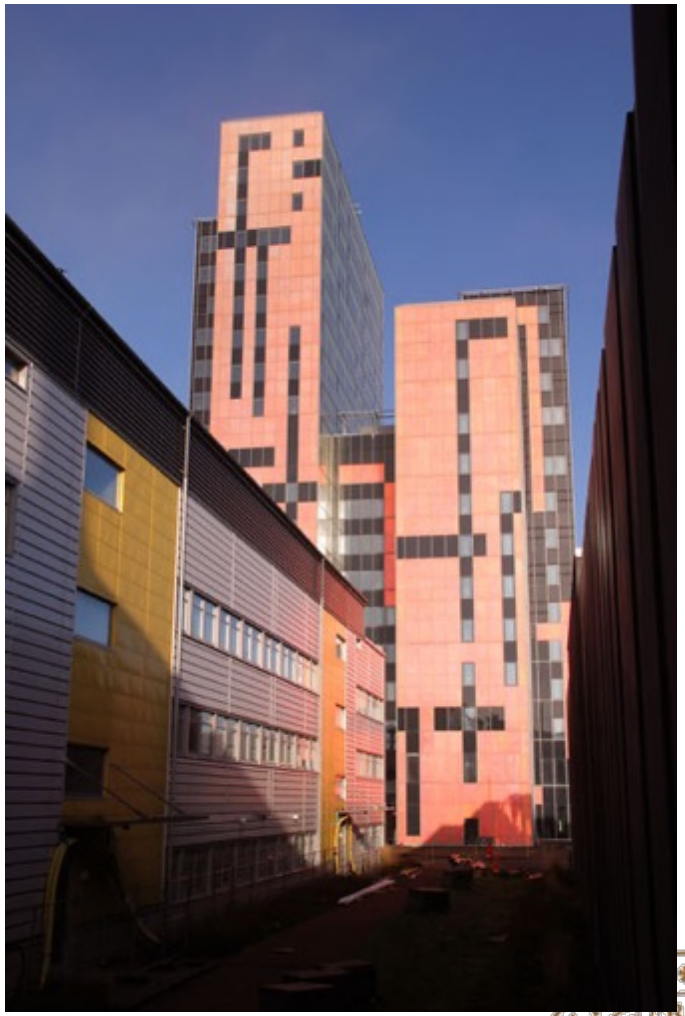
Picture Lund University, Tanja Cernosa

Complexity - Special Systems: Green Buildings

picture courtesy ID 162733442© Jordi Clave Garsot| Dreamstime.com

Different Systems – Complexity – Energy production

- Production of electricity in the facades through solar panels
- Introducing electrical ignition sources
- Problems for fire brigades



Picture Lund Univ.

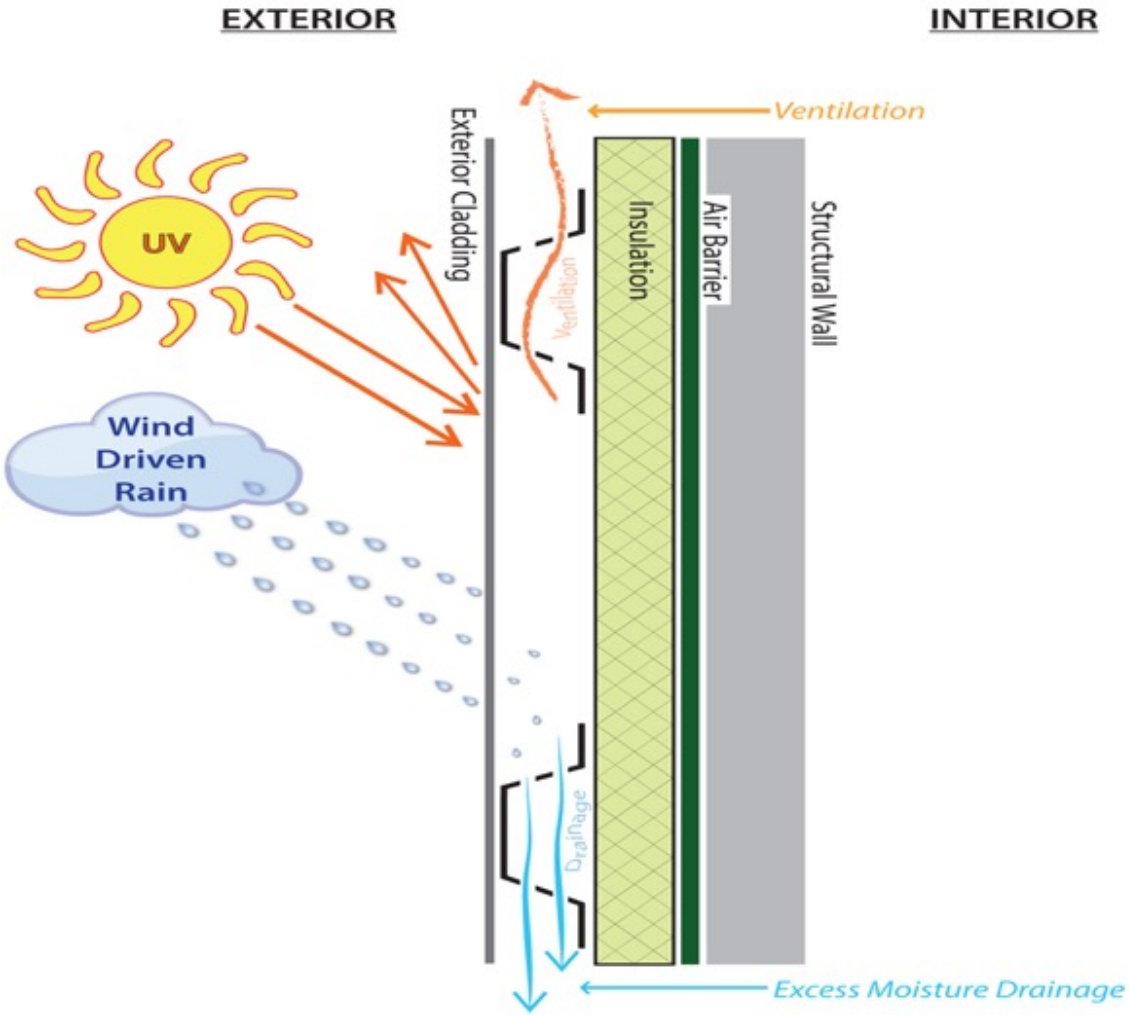
Different technical properties of façades

Based on interviews, literature study and expert meeting (at SBU) as well as a PhD course:

- Humidity
- Rain screen properties
- Insulation
- Mechanical stability for fixing systems
- Wind stability and pressure equalisation
- Acoustics
- Aesthetics
- Durability

Each type of façade system has very complex properties both for fire but also for other properties.

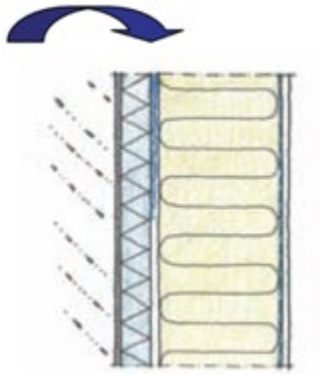
Other technical properties of façades- example rainscreen cladding



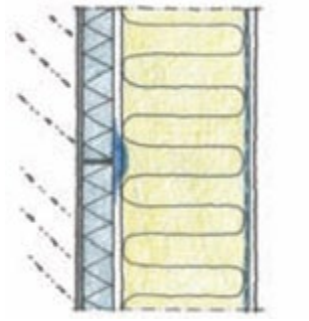
Picture LTH

Humidity problems

Leakage through cracks

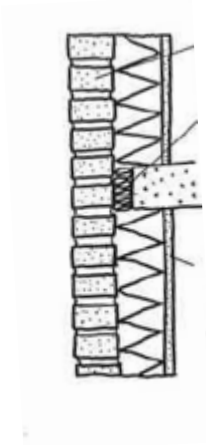


Leakage through capillarity



Pictures LTH

Combined problems: Example fire-humidity Fire stoppers



Pictures LTH, Brandskyddshandboken

Socio-Technical aspects

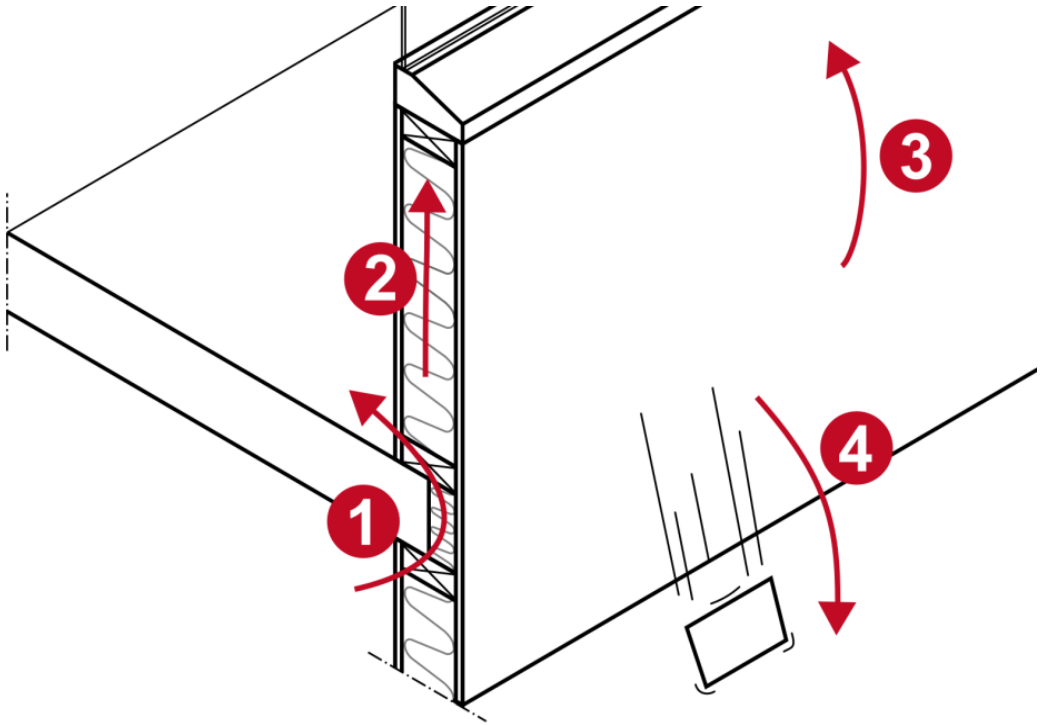
- The socio-technical building regulatory assessment model (STBRSAM)
- A socio-technical systems (STS) approach to building regulation and building regulatory system review promotes the concept of the interaction of organizational or institutional components, of technological components, and of the actors within the organization or institution, with the explicit realization that they are integrally linked.
- Performance of complex systems (buildings) with complex technology (façade systems) cannot be fully assess without consideration of socio-technical considerations of building regulatory system

Results – Sweden/England shared inadequacies

- Inadequate clarity regarding roles and responsibilities
- Inadequate understanding of expected performance (i.e., lack of criteria)
- Inadequate competency and qualifications structures
- Inadequate control and enforcement, in this case driven by uncertainty regarding the responsible entity
- Insufficient transparency, i.e. lack of audit trails and information requirements
- Inadequate communication between actors and actor levels

Different type of technical fire risks

- 4 Main cases can be considered. Specific case is spread from building to building (more details, see report)



Picture courtesy Boverket

How do we determine fire properties and consider other aspects ?

- Prescriptive solutions: Through defined requirements in the regulation and corresponding test methods
  - E.g. for reaction to fire through Euroclass B-s1,d0
  - E.g. for fire resistance through rating EI60

Comments on Euroclass methods in CPR

- CE is for products and/or materials
- How do we deal with systems ?

ACM system

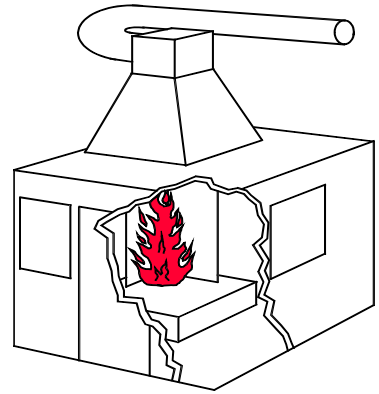
Picture Kingspan

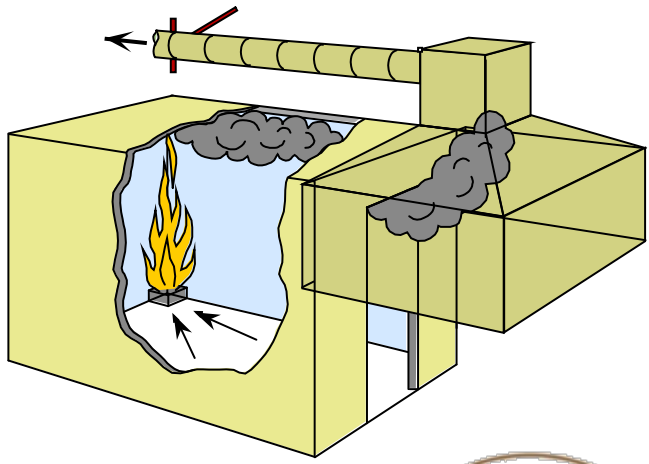
Challenges with fire tests

- Many different tests
- Different fire scenarios
- Different criteria
- Different parameters measured

- Need for harmonisation in Europe

- Pre-Study done by a number laboratories





European Methods and classification under discussion

- DIN 4102-20 and BS 8414, see paper Anderson, Boström, Hofmann et al, Interflam and report Boström et al.

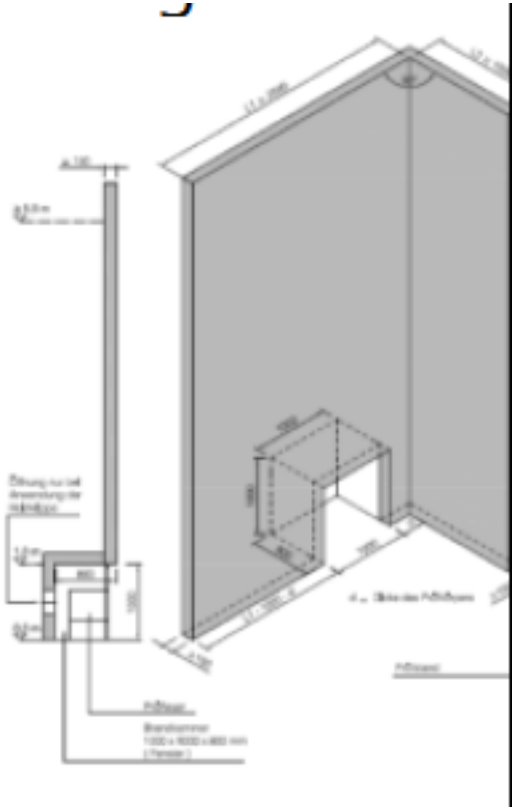


Figure A1 Example of a typical test facility

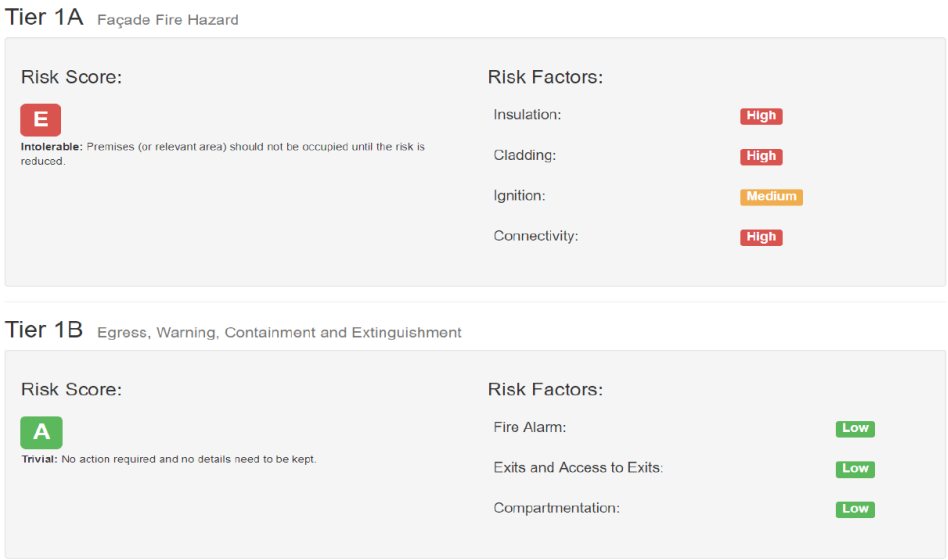
How do we determine fire properties?

- 1. Prescriptive solutions: Through defined requirements in the regulation and corresponding test methods
  - E.g. for reaction to fire the Euroclass B-s1,d0
  - E.g. for fire resistance through rating EI60
- 2. Performance based solutions - Need for input in order to be able to check fulfilment of criteria:
  - By Expert Assessment
  - By full scale tests
  - By risk tools such as Fire Risk Assessment Tool - NFPA EFFECT
  - By modelling

Picture WPI

Fire Risk Assessment Tool - NFPA EFFECT

- Web based tool (http://www.nfpa.org/exteriorwalls)
- Questions are asked and give an estimate of the risk



- Another example is from the Netherlands, Van Mierlo et al.

Alternatives – Functional design/modelling

- Here input date are needed for:
  - Expert advises
  - Full scale date with extra measurements
  - By numerical models
- Important to look to the whole system!

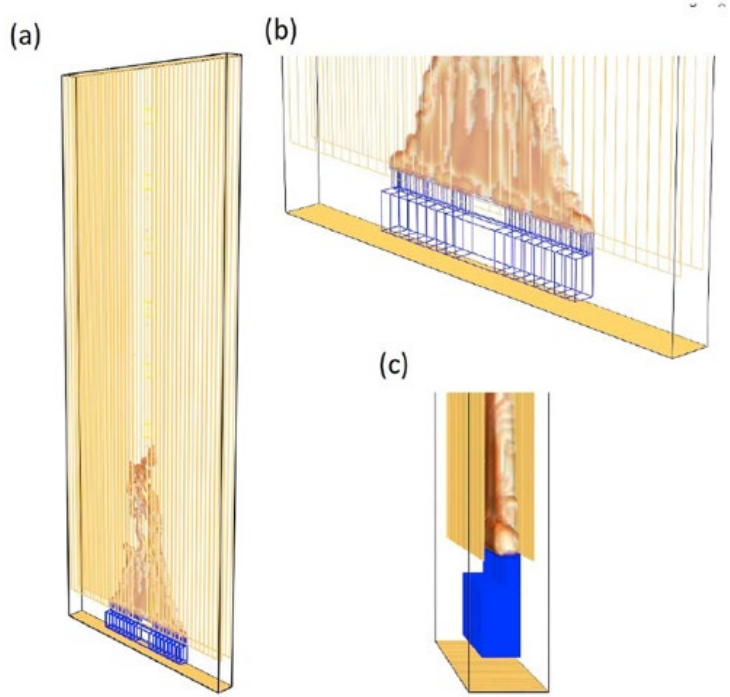


Fig. 1. The model geometry and axis for the cavity arrangement (a) computational domain (b) and (c) burner closeups. Obstacles are hidden in (a) and (b) for clear visualization.

Picture Livkiss, DBI

Conclusions

- Important to further define a façade system
- Different façade systems exist and are not easy to categorize.
- The different technical properties and their requirements differ depending on the category of façade system.
- Façade construction is very complex and are complete systems and not single materials or products. Fire safety evaluation of one single material to promote or to forbid systems is not favourable.
- Further, buildings are complex systems, which reside within complex sociotechnical building regulatory system (STBRS)
- A first order socio-technical building regulatory system assessment model (STBRSAM) illustrates challenges with current regulatory system approaches

Conclusions

- Consideration of different risks is important, and risk analysis tools are very promising for screening
- Before introducing test standards into regulations, regulators should identify which risk they want to reduce and choose the appropriate performance criteria or safety levels.
- Once risk / safety levels are established, a suitable test method (e.g. full scale) or a suitable performance-based solution based on sound fire safety engineering can be chosen. The latter allows full innovation.
- A holistic approach is therefore necessary for the future to address the many needs

Research questions / gaps

- A clear façade definition is needed.
- Further categorisation of façades.

- Further work on socio-technical issues and the STBRSAM is needed.

- Case-studies for overall properties of façade systems by evaluating e.g. 10-15 different façades (blinded) from a scientific view point
- Case-studies of expert evaluations (blinded) from a scientific view point to learn more about the methods used.

Research questions / gaps

- Use/Development of risk evaluation tools in Sweden.
- Screening evaluation of façades by intermediate scale tests

- Input data for modelling of façades, what is needed, how can they be validated
- More robust engineering tool(s) with enough details.

Dissemination results in this project

- Two articles at Interflam 2019
- Presentation at fire seminar in Antwerp 2019
- Presentation Spanish SFPE chapter seminar September 2019
- WP 3 report from BRIAB as well as LTH report of project
- Master thesis from Bogdan Branisteanu Albulescu
- 1 Fire Technology Journal paper on flames in voids in cooperation with DBI
- 1 Fire Safety Journal paper on flames in voids in cooperation with DBI
- 1 Fire and Materials Journal paper on STBRAM in review
- 1 poster at ESFSS in Nancy with DBI on screening methods
- PhD course December 2018.

Acknowledgements

- Brandforsk as main sponsor.
- Co-sponsors STEM (Swedish Energy Agency), STINT, EU DG Grow, Erasmus Mundus partners, DBI.
- Project partners: LTH, Briab and Meacham Associates for their own contributions.
- Project Group of SBU:
  - Jan-Olof Dalenbäck, Angela Sasic Kalagasidis, Chalmers University
  - Folke Björk, KTH
  - Peter Wallentén, Miklós Molnár, Stefan Olander LTH, Lars Wadsö, LTH
  - Michael Försth, LTU
  - Lars Boström, Johan Andersson RISE
- Members of the reference group:
  - Lars Brodin (Brandskyddsföreningen)
  - Anders Johansson (Boverket)

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Report available on request.
Detailed presentation: https://www.brandforsk.se/seminarier-och-workshops/an-holistic-approach-for-fire-safety-requirements-and-design-of-facade-stystems-holifas/