

Structural elements made of bio-based materials and detailing – WG 2 of Cost Action FP1404

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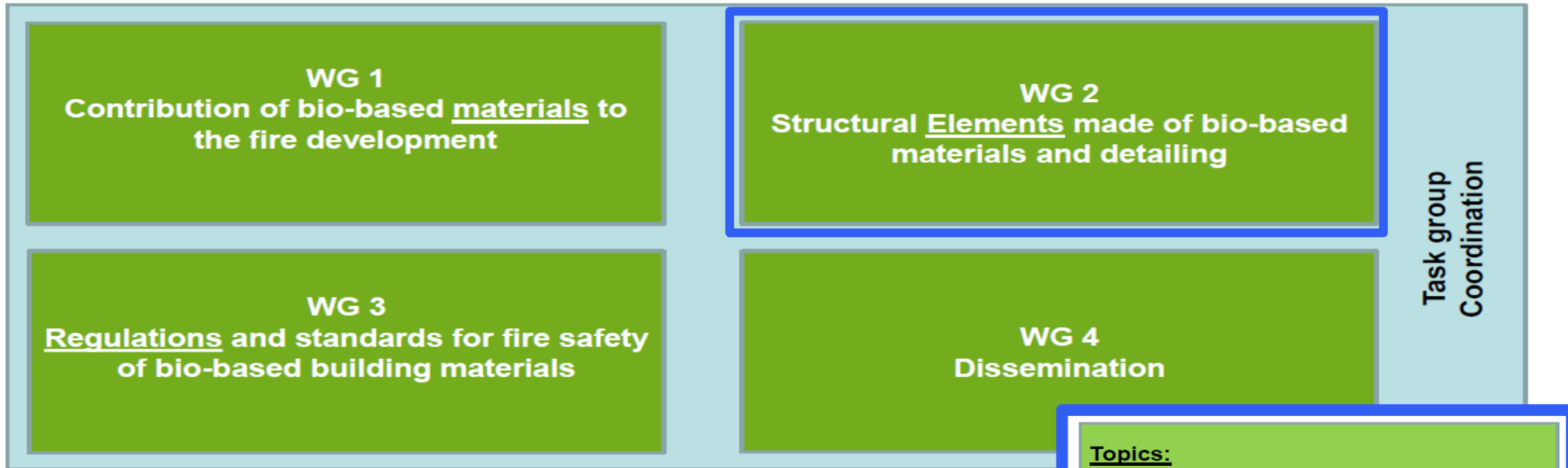
Tallinn, 2015-03-04



TTÜ 1918



Working groups of FP1404



Topics:

- Fire resistance of bio-based structural elements
- Material properties and protection methods
- Effects of constructions detailing for fire safety

Deliverables:

- Comparison and collection of data
- Best practice

Introduction

What structural bio-based materials are interesting in this context?



The key requirement for ‘Fire Resistance’

A common *performance requirement* is that:

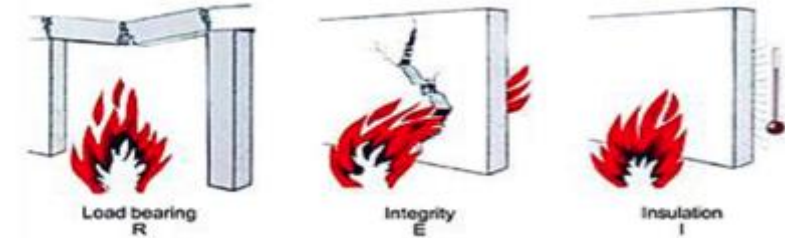
“Any building shall be designed and constructed so that, in the event of fire, its *stability* will be maintained for a *reasonable* period”



Fundamental Concept: Fire Resistance

WG2 activities focus on **'FIRE RESISTANCE'**

- Various different meanings are sometimes applied



“Selected structural members and non-structural barriers are provided with **fire resistance** in order to **prevent the spread of fire and smoke**, or to **prevent structural collapse** during an uncontrolled fire”

- Fire resistance is **'passive'** fire protection
 - Always ready and waiting for a fire
 - As opposed to **'active'** measures which only act once a fire has been detected
 - Fire resistance is only one part of the strategy, which usually uses some combination of active and passive

Fundamental Concepts: Importance of Fire Resistance

- Little significance in early stages of a fire
- Depends on **size of building & fire safety objectives**
- Essential in all buildings **where fires could grow large** before occupants can escape
 - Tall buildings, hospitals, prisons, etc.
- Important for **fire service access and rescue**
- Most **important for property protection and externalities (increasingly?)**



Fundamental Concepts: Stages of Fire Development

- **Pre-flashover:**

- Fire is confined to a room, one or two items burning
- People must escape in this phase

- **Post-flashover:**

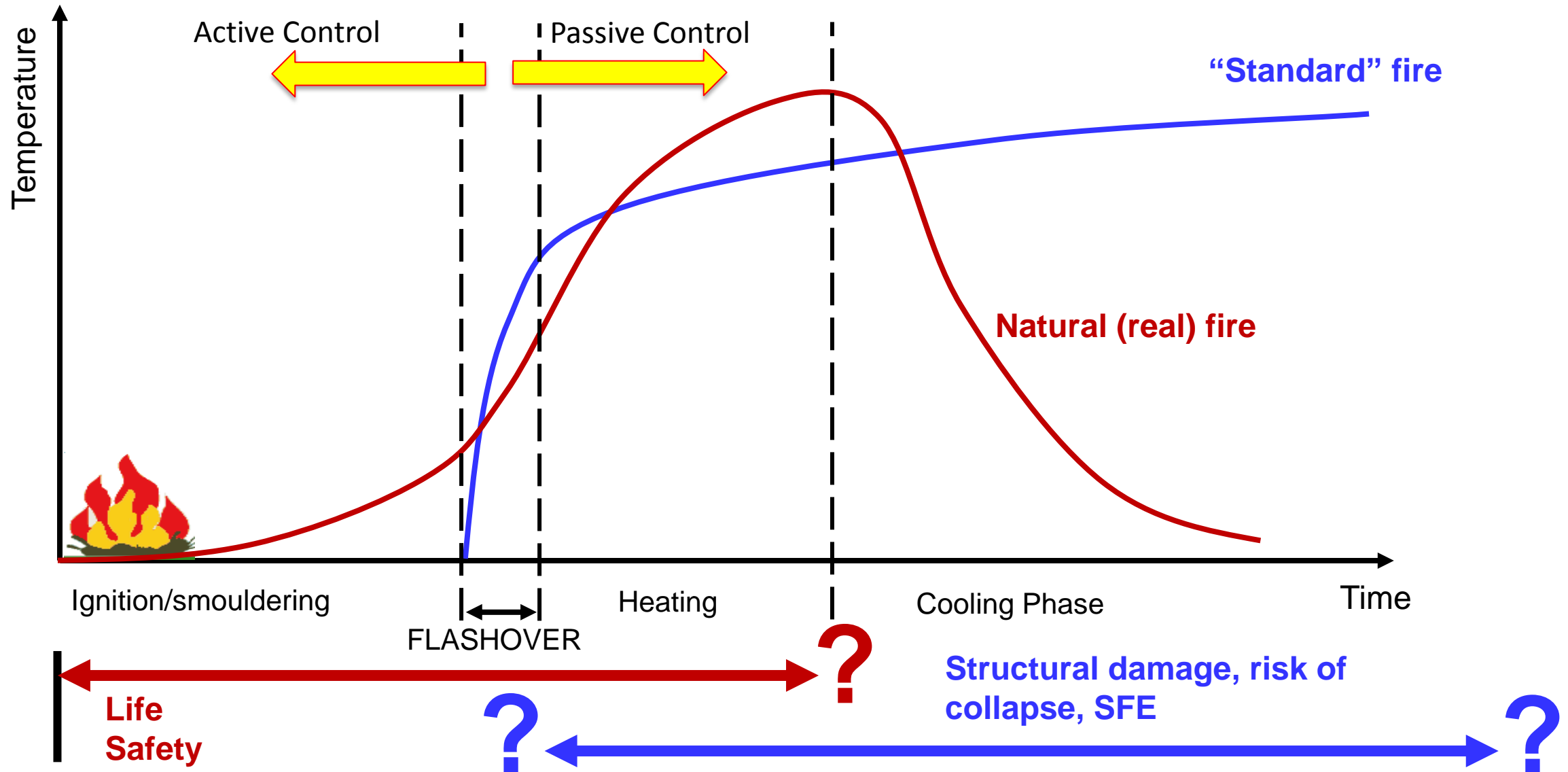
- Occurs only in confined spaces
- All surfaces in room burning at once
- Intense heat – survival not possible
- Critical phase for structural integrity

- **Flashover is the transition from a localized fire to combustion of all exposed combustible surfaces**

- Generally occurs when the “hot layer” reaches 600°C
- Survival is impossible

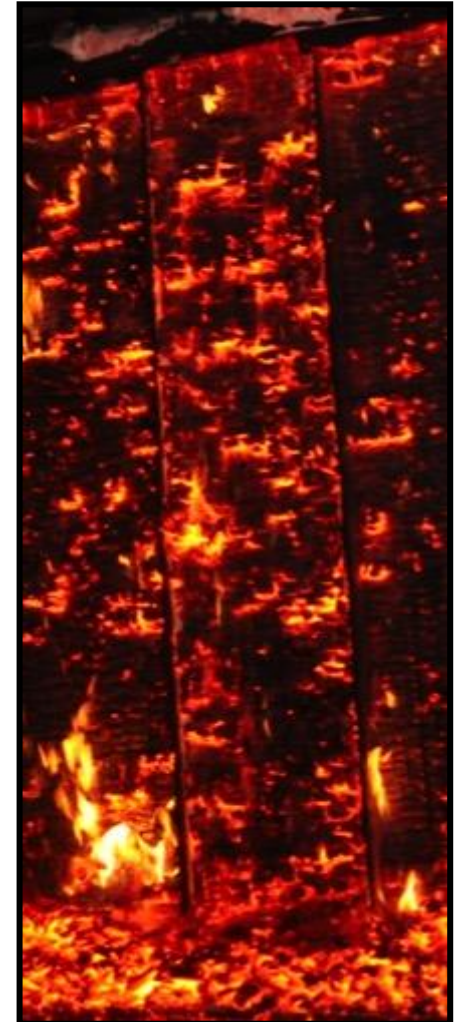


Fire Development – When do we need fire resistance?



Fundamental Concepts: Performance vs. Prescriptive Codes

- Until recently only prescriptive SFE codes existed:
 - Sets of specific, rigid rules, often with historical or heuristic origins
 - Describe **how a building must be constructed**
 - Little chance for designers to take a rational, physics-based approach
- Most countries have also adopted performance-based approaches:
 - A set of goals or performance objectives
 - State **how a building is to perform under a wide range of conditions**
 - Allows designers to use any fire safety strategy they wish, provided that **adequate safety** can be **demonstrated**



Current situation in Europe

- Increase use of bio-based materials due to **performance-based design criteria**
- National building regulations effectively opened the market for bio-based building products
- Tools and guidelines often limited to non-combustible building materials
- Significant differences between **building regulations in different countries**
- Performance of bio-based building materials and structural systems under **non-standard (i.e. 'natural') fire scenarios** is poorly developed
 - **Hinders PBD of mass timber buildings**



Recent developments

2007-2010 WoodWisdom project:

“Fire Safety in Timber Buildings”

- Outcome: State of the art Guideline
- New Structural timber elements (e.g. CLT)
- New design methodologies
- Guidance for the use of Eurocodes and European system for the verification of fire safety



Revision of EN 1995-1-2:2020

- Simplification (delete RPM, keep RCSM)
- Harmonization
- Improvement / extension
 - Significant input from COST Action FP1404 planned



European
Commission

Projects

For the Revision of EN 1995-1-2:2020

Improvement / extension

- Cross-laminated timber panels, timber-concrete-composite elements
- Connections (various)
- Cladding materials / systems
- Separating function



Projects of general importance

- Database of info on structures fulfilling certain fire classes
- Material property data and fire protection methods in for natural fire exposures
- Guidance and best practice on sequencing and detailing during and after construction

Collaboration between FP1303 and FP1404?

- FP1303 can provide information on a large variety of bio-based building materials and systems which are being developed in Europe:
 - Species and basic thermal/physical/mechanical properties
 - Products (CLT, LVL, Glulam, cassette systems, etc) and adhesives
 - Connection details and materials (metallic, dowelled, timber, polymer composite, etc)
- All types of bio-based structures require defensible fire design methods for their safe, efficient, and confident application in real projects:
 1. Load-bearing capacity
 2. Integrity
 3. Insulation



Thank you for your interest. Please feel free to contact us!

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Future challenges & research needs

Collecting and generating knowledge to remove prescriptive constraints and unlock potential:

1. Database of **information on the fire performance of bio-based materials**, elements, and systems
2. Reactive, thermal, and mechanical **material properties of relevant bio-based building materials** (and fire protection methods)
3. Structural response, and hence **fire resistance, of novel bio-based structural elements and systems** exposed to a range of standard and natural fire scenarios
4. Construction **detailing and structural connections for achieving fire safety** in a bio-based built environment (best-practice guidelines)

