Lunch & Learn - Fire Safety for Timber Buildings. Micro-Certificate

Dr Felix Wiesner

THE UNIVERSITY OF BRITISH COLUMBIA
Faculty of Forestry

BC fire deaths

2022

- 86 deaths
  - 52 in structures
  - 27 in vehicles
  - 1 in outdoor fires
- Out of 9,087 fires, of which 3,193 were structure fires and 4,631 were outdoor fires

2023

- 62 deaths
  - 37 in structures
  - 12 in vehicles
  - 4 in outdoor fires
- Out of 12,342 fires, of which 4,459 were structure fires and 6,196 were outdoor fires.

2024*

- 61 deaths
  - 33 in structures
  - 22 in vehicles
  - 0 in outdoor fires
- Out of 9884 fires, of which 3264 were structure fires and 5313 were outdoor fires.

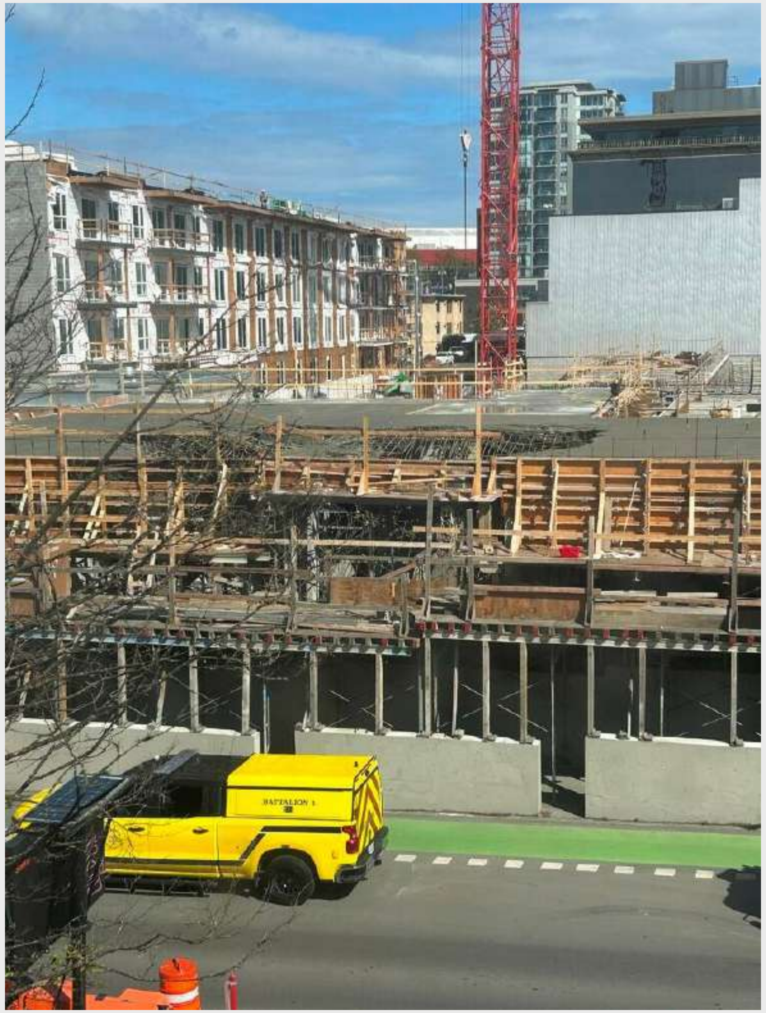
For comparison

- Drowning deaths in BC: 94 & 101 in 2022 and 2023, respectively.
- Uncontrolled drug deaths: 2382 & 2581 in 2022 and 2023, respectively.

But … Can we compare deaths from public health with deaths from fire?

If we consider building code objectives – how many people have died in BC due to structural collapse?

?



Ceiling collapse shuts down Old Town work site - Victoria Times Colonist, (n.d.). https://www.timescolonist.com/local-news/ceiling-collapse-shuts-down-old-town-work-site-10514914 (accessed April 28, 2025).

The role of Building Officials

- Authorities having jurisdictions
- Upholding minimum acceptable building regulations/standards
- Empowered by the Building Act 2015
- Broad knowledge base to act as generalists based on the implementation of prescriptive building codes

Building Officials

- Need to review and assess:
  - Fire Protection
  - Accessibility
  - Structural Design – i.e. load bearing capacity of a building
  - Security
  - Health
  - Environmental Impact

Building design and construction by specialists

Shangri-La Vancouver

Owner/Developer	KBK #1 Ventures Ltd.
Architect Design	James KM Cheng Architects
Structural Engineer	DIALOG Jones Kwong Kishi Consulting
MEP Engineer	Sterling, Cooper & Associates
Vertical Transportation	Fujitec America, Inc.
Wind	RWDI

Generalists ‘vs’ Specialists

Provides guidance

Provides direction

“A fire Protection Engineer is an individual who, by formal training and professional experience, carries the necessary competency, and has the skills to provide guidance and direction to protect life, property and environment from threats posed by fire and its related mechanism.”

-SFPE Recommended Minimum Technical Core Competencies for the Practice of Fire Protection Engineering-

Role of FPE

Architecture

- Smoke Management
- Evacuation
- Access for Fire Brigade

Structure

Mechanical Engineering

- HVAC systems
- Hydraulic Systems

Civil / Structural Engineering

- Fire Resistance

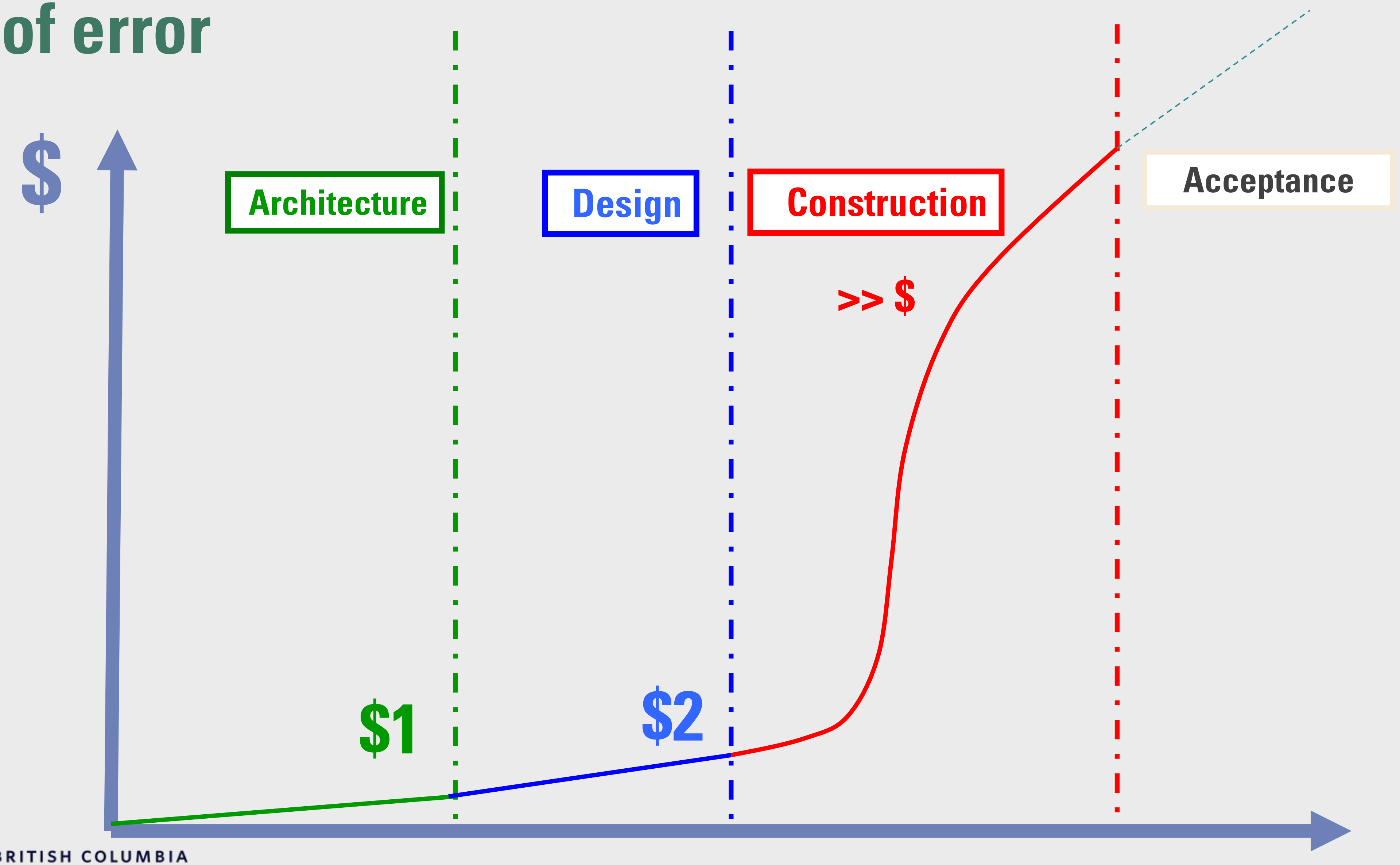
Fire Safety Engineering

- Detection & Alarm
- Smoke Management
- Suppression & Control
- Fire Resistance
- Reaction to Fire
- Evacuation
- Access for Fire Brigade
- Security

Why a micro-certificate

- CPD
- Match expertise with innovation.
- Provide a non-degree option for working professionals who are not fire protection engineers.
- Believe that holistic design can yield construction benefits.
- Specialist knowledge in alternative solutions can be hard to assess for generalists

The cost of error



Other considerations beyond deaths from fires

If fire safety is our primary objective in design:

We also need to consider
- Cost
- Environmental impact
- Construction speed
- Density

Good design needs to account for all of these aspects – better understanding of these different areas can help with this.

Course 1: Fire Safety Regulations and Their Background

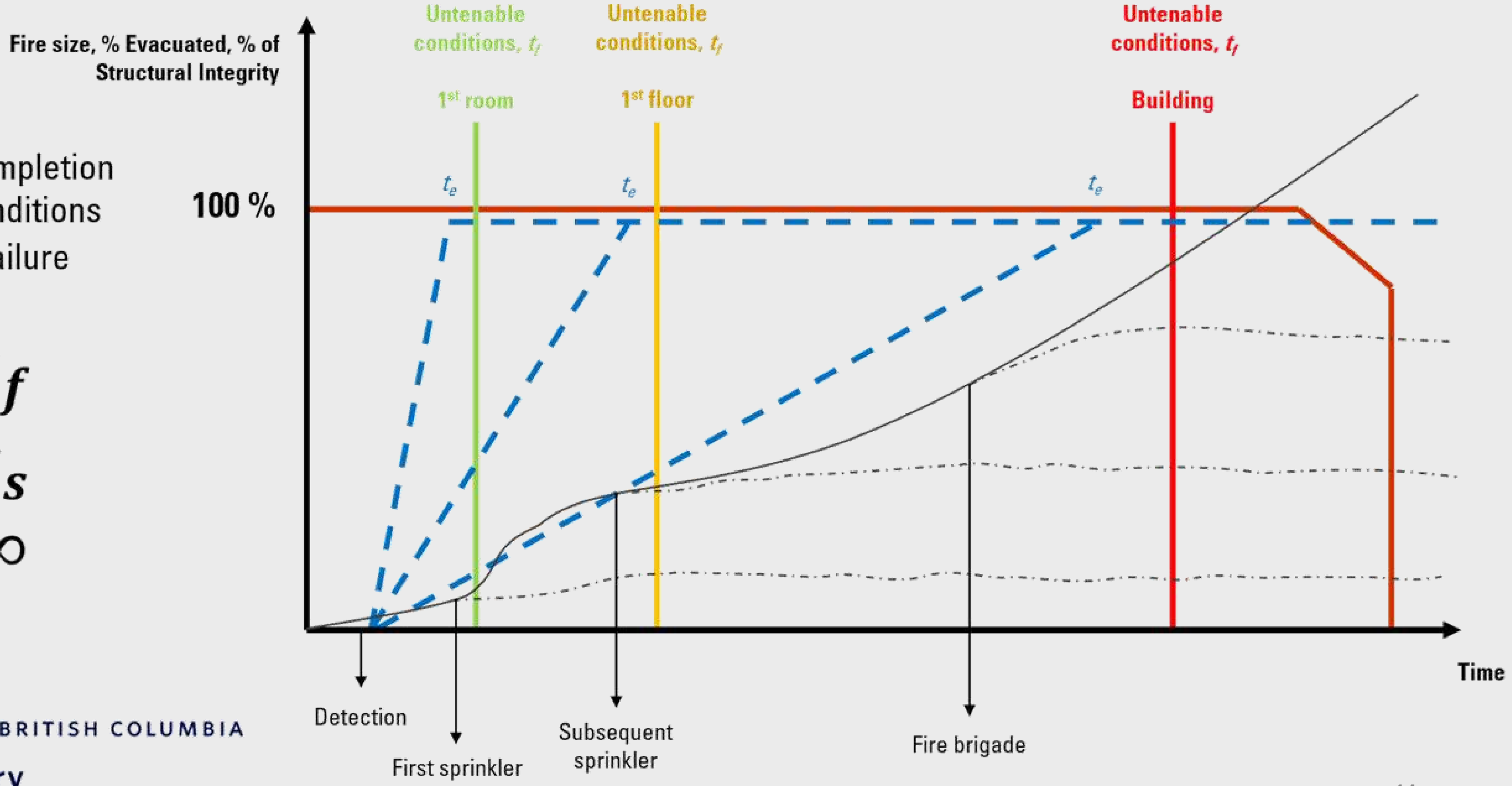
Learning outcomes:

- Instill a solid understanding of the need for fire safety.
- Explain and evaluate the role of fire safety in the built environment and its implementation in modern building codes.
- Develop a distinction between Acceptable and Alternative solutions.
- Question fire safety measures in the context of an overall Fire Safety Strategy

Fire safety strategy timeline

t_e = evacuation completion
t_f = untenable conditions
t_s = structural failure

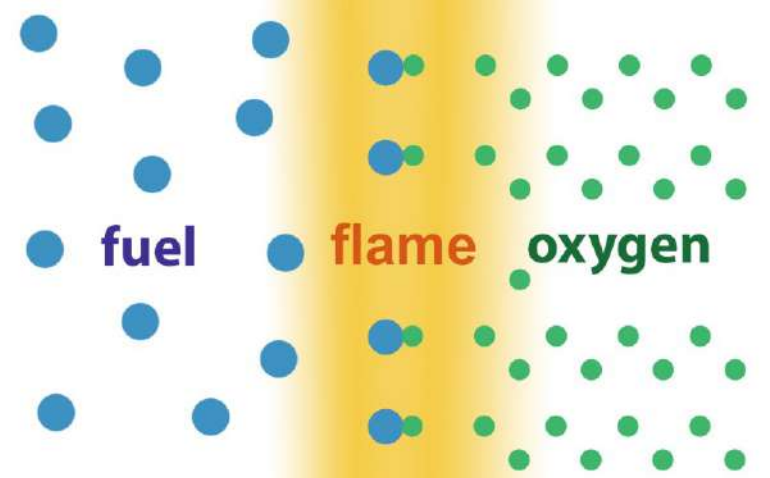
$$t_e \ll t_f$$
$$t_e \ll t_s$$
$$t_s \to \infty$$



Course 2: Fire Science for Wood Products

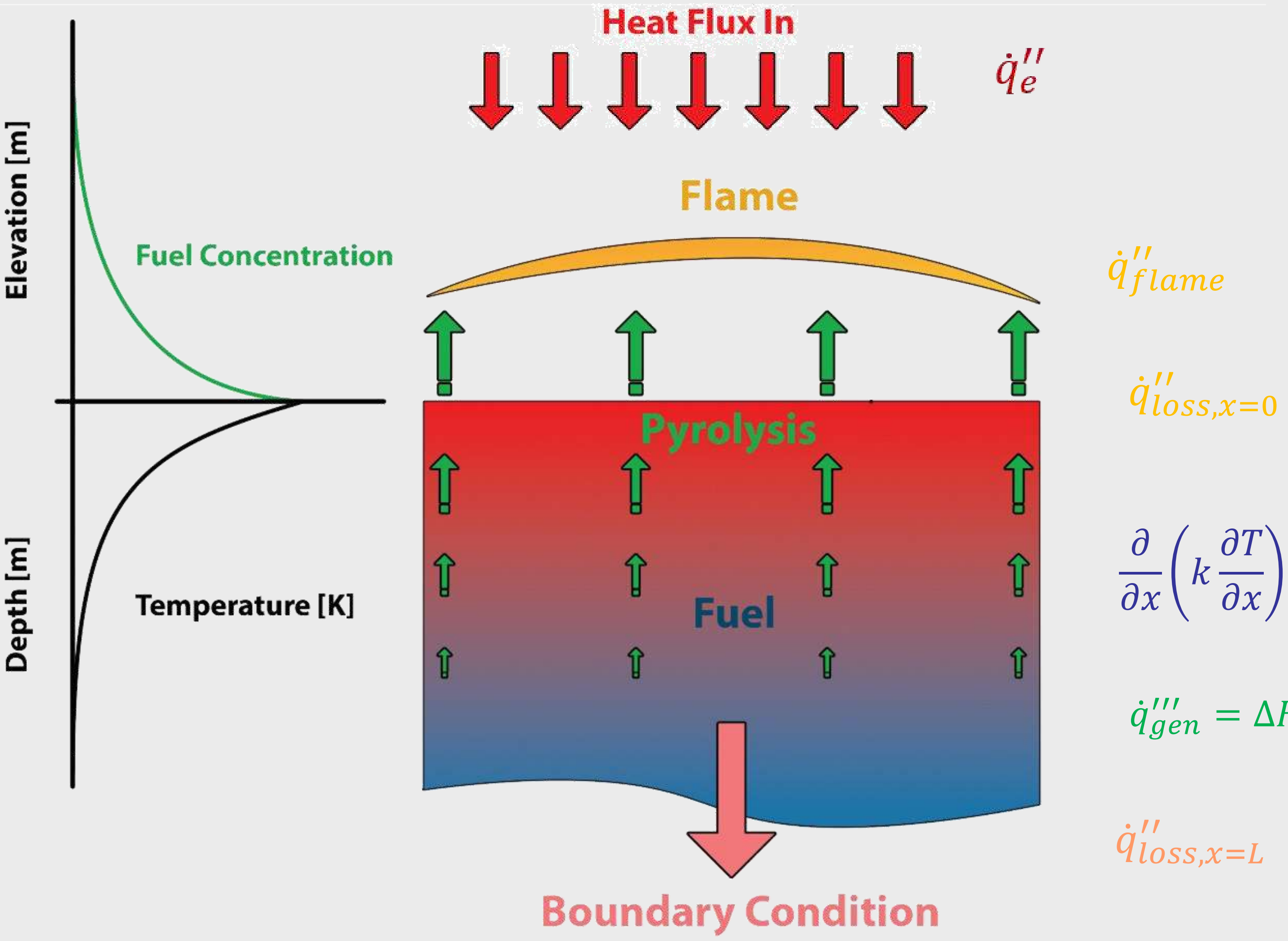
Learning outcomes:

- Describe the scientific principles that govern fire development in buildings.
- Explain pyrolysis and its role in creating flaming combustion.
- Identify different modes of heat transfer.
- Illustrate processes of ignition, flame spread, and steady burning



Ignition depends of lower (lean) and upper rich flammability limit to create a flammable mixture of fuel and oxygen.

If we have such a mixture then all we need is to provide activation energy – e.g. a spark or a match.



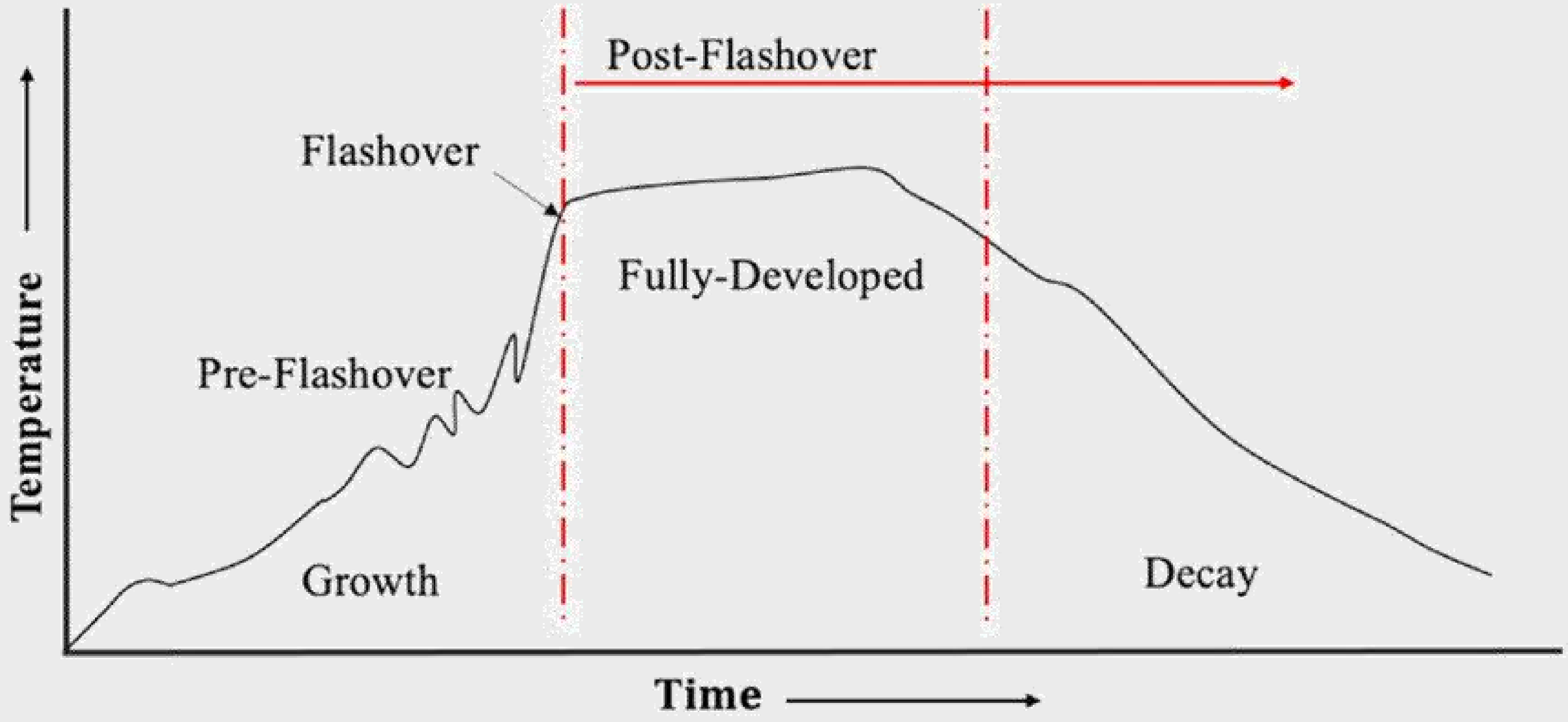
$$\frac{\partial}{\partial x}\left(k\frac{\partial T}{\partial x}\right) = \rho c\frac{\partial T}{\partial t} + \dot{q}_{gen}'''$$

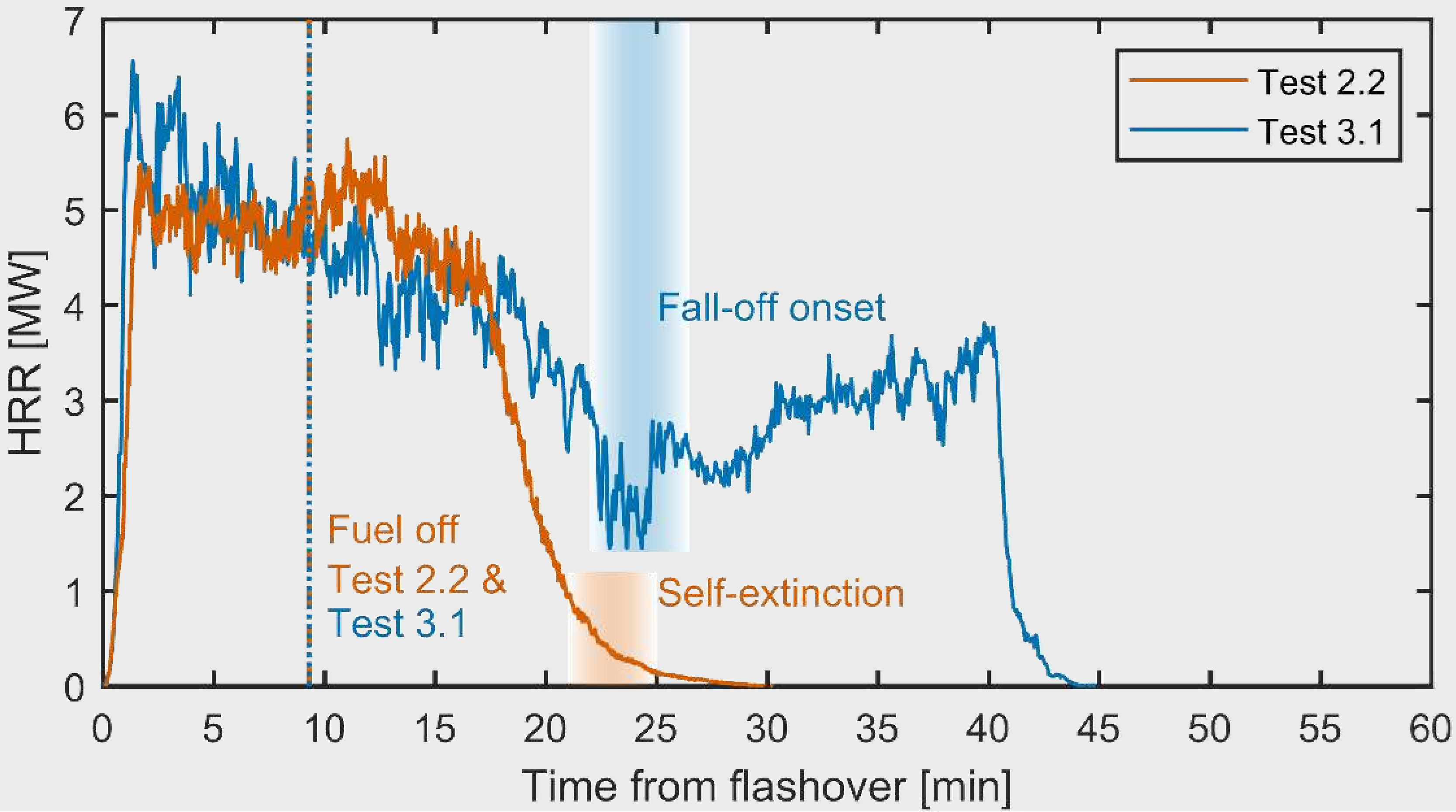
$$\dot{q}_{gen}''' = \Delta H_p \cdot \dot{m}_p'''$$

Course 3: Compartment Fires and Fire Resistance

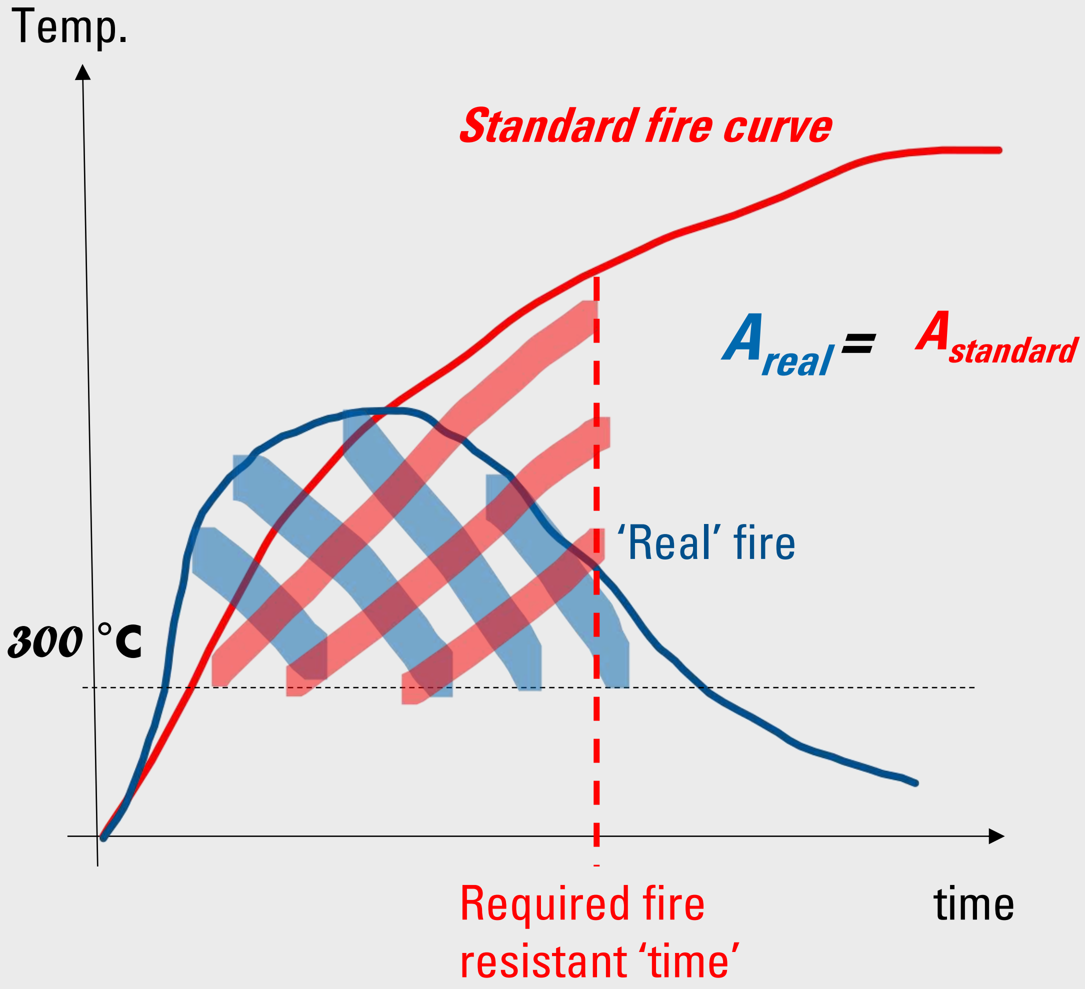
Learning outcomes:

- Describe stages and regimes of compartment fires in non-combustible compartments.
- Apply basic concepts of compartment fire theory.
- Examine the effects of exposed timber on compartment fire stages.
- Discuss history and application of the fire resistance framework.


Post-Flashover
Flashover
Fully-Developed
Pre-Flashover
Temperature
Growth
Decay
Time



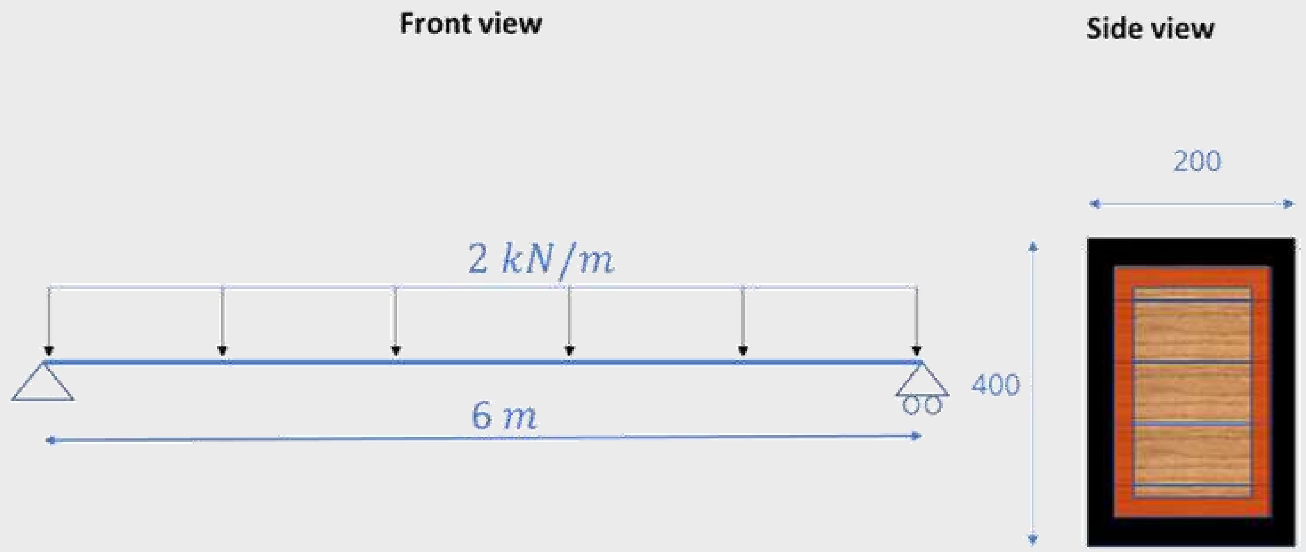
HRR [MW]
Time from flashover [min]
Test 2.2
Test 3.1
Fall-off onset
Fuel off
Test 2.2 &
Test 3.1
Self-extinction
0
1
2
3
4
5
6
7
0
5
10
15
20
25
30
35
40
45
50
55
60


Temp.
Standard fire curve
$A_{real} = A_{standard}$
'Real' fire
300 °C
time
Required fire resistant 'time'

Course 4: Applications of Fire Safety for Timber Buildings

Learning outcomes:

- Apply codified calculation procedures to determine the fire resistance of structural mass timber elements
- Formulate sprinkler activation times for different fires and sprinkler types
- Recognize advanced fire engineering model tools
- Describe emerging issues for timber building fire safety

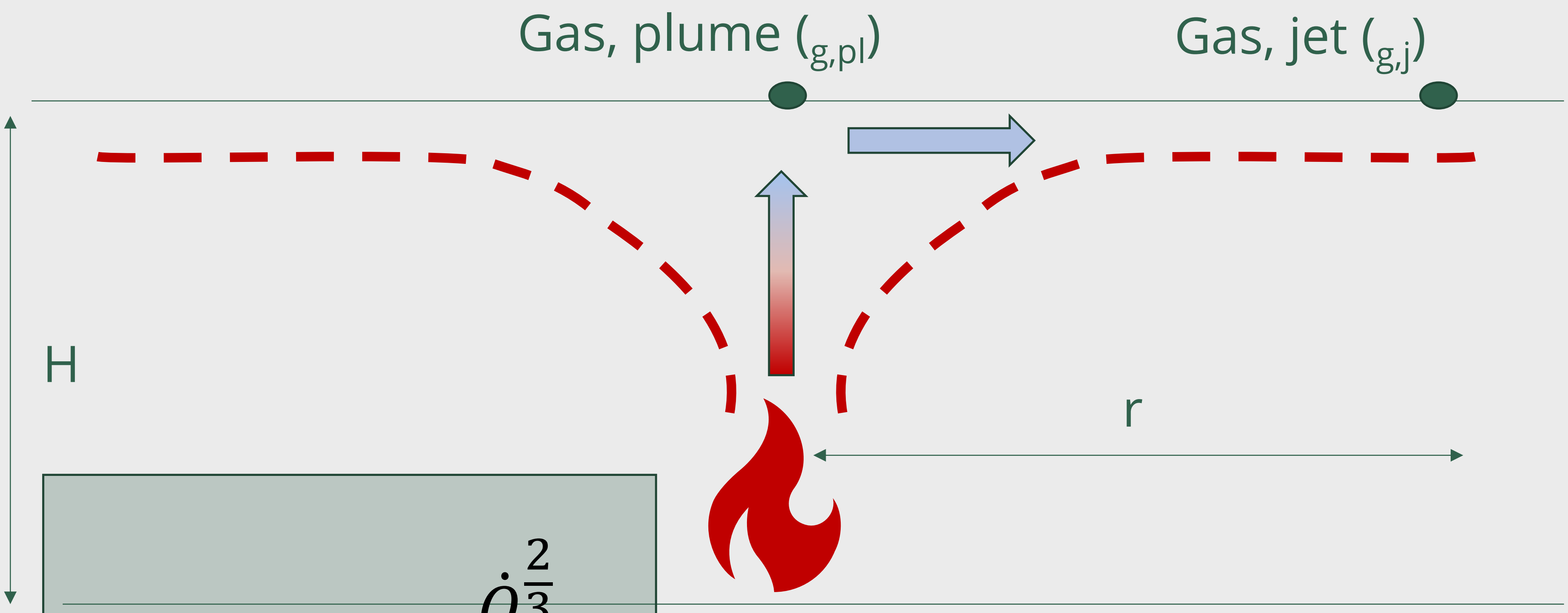


Inputs

- Beam length: 6 m
- Beam material: Glulam
- Uniformly distributed force: 2 kN/m downwards
- Supports: Simply supported
- Targeted fire resistance duration: 60 minutes
- Modulus of rupture: 15 N/mm^2

Problem

The beam cross-section is rectangular with initial dimensions of 400 mm x 200 mm.
Validate whether the wooden beam can withstand a standard fire of the stated duration before it ruptures.



$$\Delta T_{g,pl} = 16.9\,\frac{\dot{Q}^{\frac{2}{3}}}{H^{\frac{5}{3}}}$$

Micro-certificate delivery

- 4 courses
- Each course takes 2 weeks
- Estimated time commitment 7.5 hours per week
- Asynchronous material
- ~2 assignments each week, some calculations, some reflections
- Weekly coffee hour, 1 hour of live video call

Asynchronous content

- Online learning is different from in-person teaching
- Shorter attention span
  - Short pre-recorded 'mini lectures'
  - + written summaries of videos and additional material
- Assignments with deadlines – but we are flexible


Combustion
Chemistry
Decomposition
CH_4 + $2O_2$ ⟶ CO_2 + $2H_2O$
Flammability
Ignition
Flame Spread
Compartment
Fires
Fire Growth
00:31
Structural Fires
Structural
Integrity
PHYSICAL SIZE


$\dot{m}_{out}$
$v = 0$, neutral plane
$\dot{m}_{in}$

Account
Dashboard
Courses
Calendar
Inbox
History
Commons
Help

Home
Announcements
Zoom
Syllabus
Modules
Grades
Discussions
Assignments
Quizzes
Files
Pages
Outcomes
Rubrics
People
New Analytics
Settings

Convection

Newton's law of cooling describes the rate of heat transfer from a surface by convection:

$$\dot{Q}_{conv} = h_{conv}\, A_s\, (T_\infty - T_s) \quad (18)$$

T_s is the surface temperature, T_∞ is the temperature of the fluid sufficiently far from the surface, A_s is the surface area through which convection occurs, and h_{conv} is the convection heat transfer coefficient.

h_{conv} [W/(m^2.K)] is an experimentally determined parameter and depends on all factors that influence convection, such as the fluid velocity, the properties of the fluid, the shape of the body, the nature of the fluid motion (laminar/turbulent), and type of convection (natural/forced). It is not that easy to determine analytically for a very fundamental reason: The no-slip condition at the surface of an object.

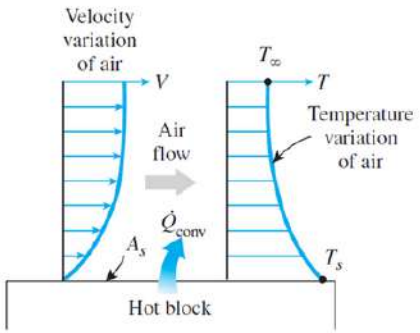


Figure 1: Boundary layer for a hot block cooling in air. [1, p. 26]

The no-slip condition states that the velocity of air at the surface must equal the velocity of the solid surface. This condition, which generally applies to viscous fluids, creates a gradual variation of fluid velocity from 0 at the surface to the maximum free stream flow velocity far from the surface, as in the figure above. The layer that sticks to the surface causes its adjacent fluid layer to slow down

THE UNIVERSITY OF BRITISH COLUMBIA

Faculty of Forestry

www.forestry.ubc.ca

FIND US ON: