ANALYSIS OF THE TEMPERATURE IMPACT ON BUILDING ELEMENTS IN FIRE CONDITIONS, WITH THE USE OF EXPERIMENTAL METHODS AND COMPUTER MODELS

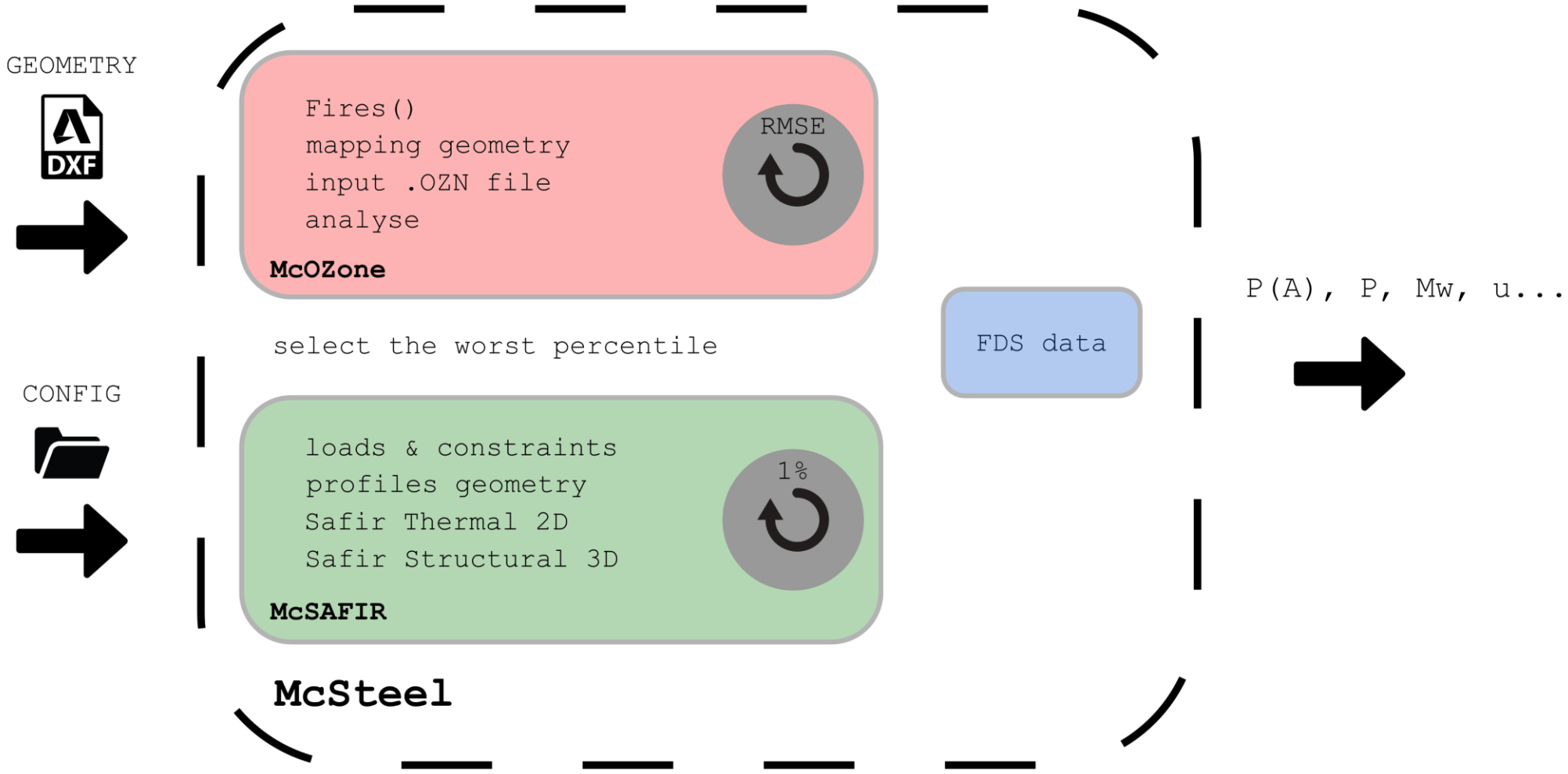
PhD Students‘ Seminar on Fire Safety Science 2021

Andrzej Krauze

The Main School of Fire Service

Warsaw, Poland

McSteel



Source: own study

Polish technical and construction regulations

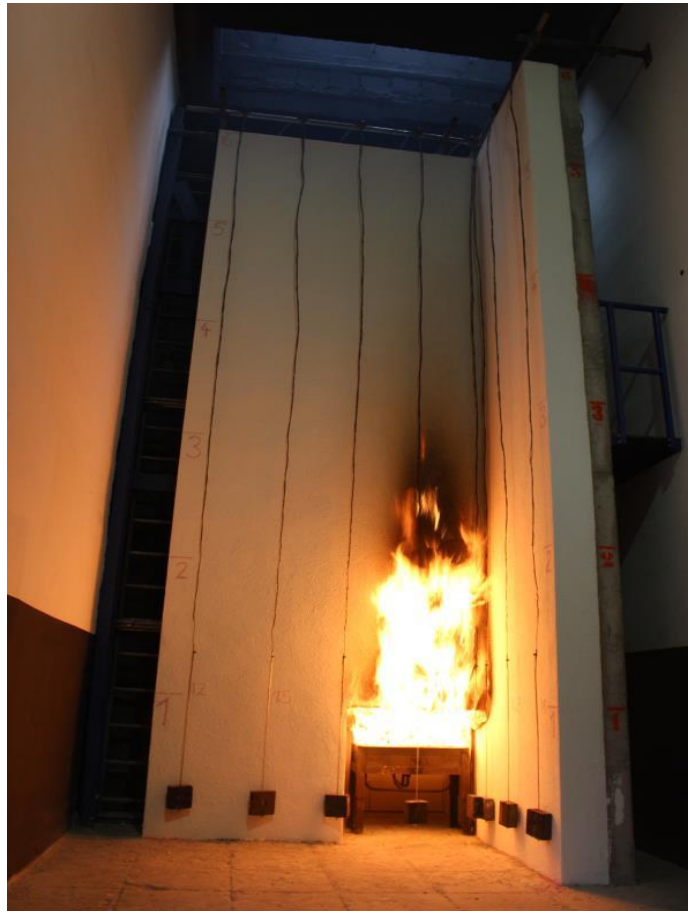
Elements of facade cladding should be attached to the building structure in a way that prevents them from falling off in the event of a fire, within the time prescribed by regulations.

Facade design for fire safety

Source: https://research.csiro.au/

Source: /www.firerescue1.com

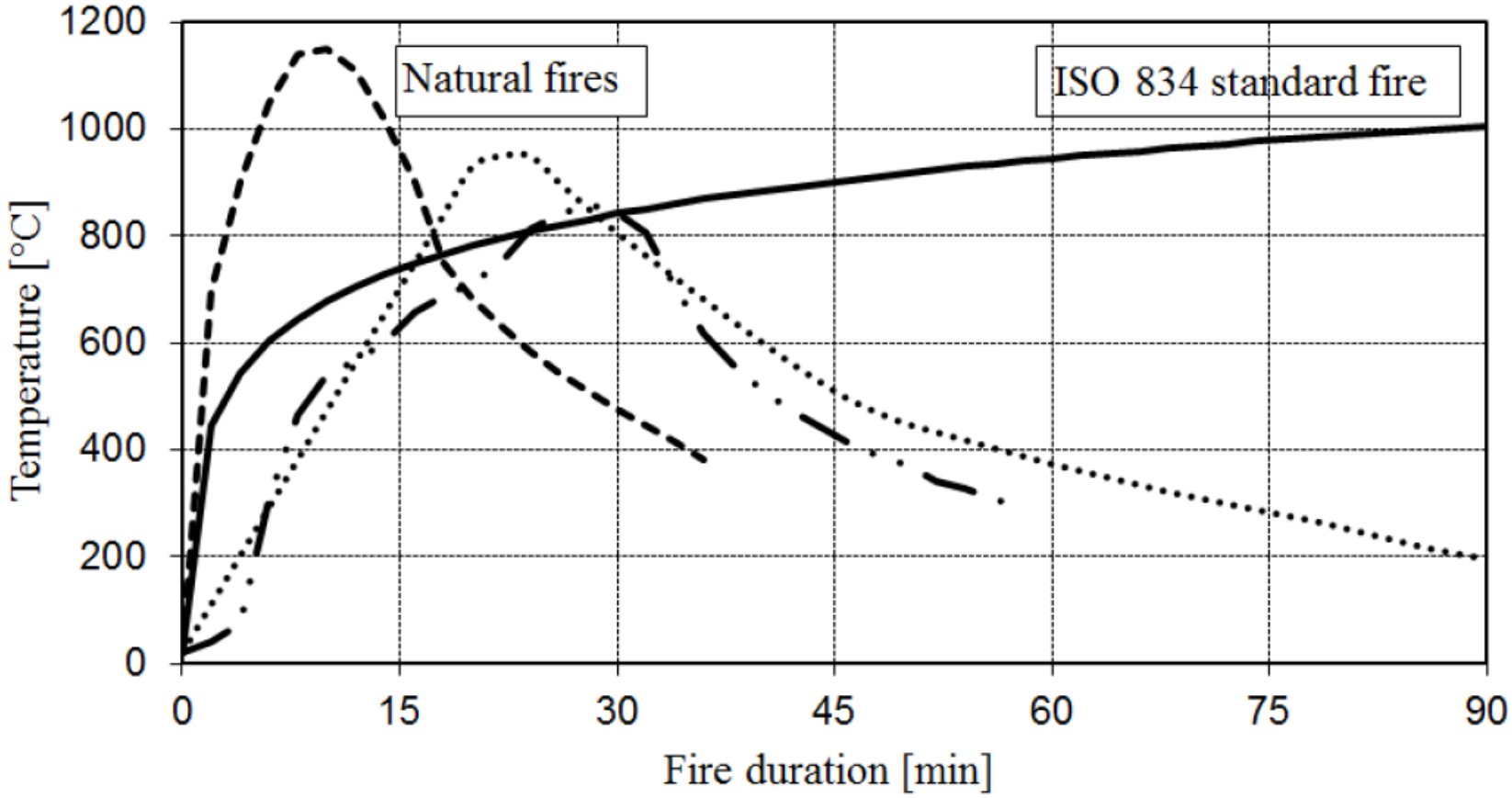
The fire performance of facades



Source: DIN 4102-20

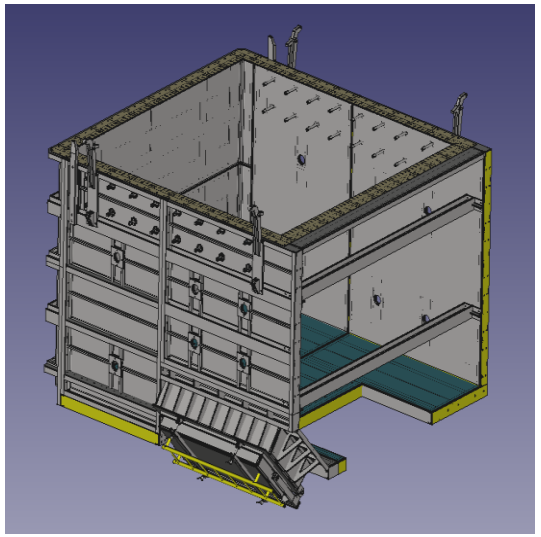
Source: BS 8414

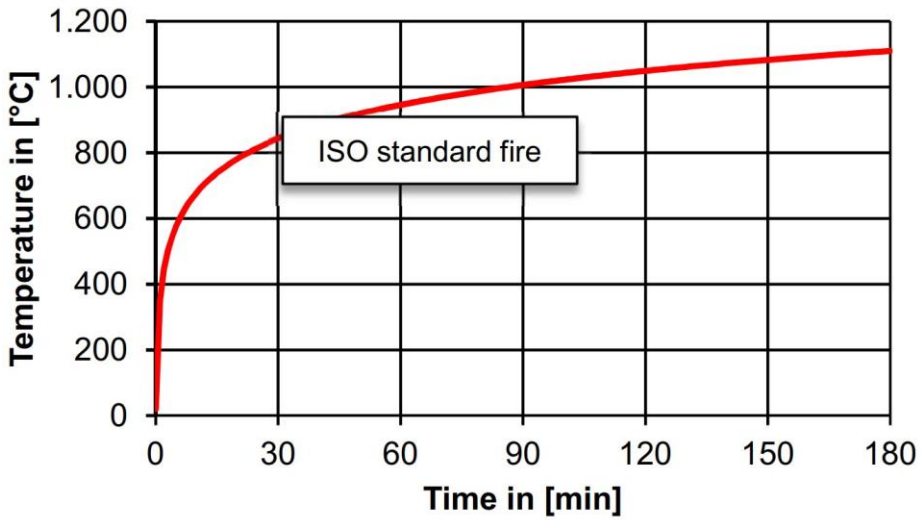
Natural fire model for the structural fire design



Source: Lyzwa, J., Zehfuss, J.: Thermal material properties of concrete in the cooling phase. ASFE conference 2017

Repeatability of the test method

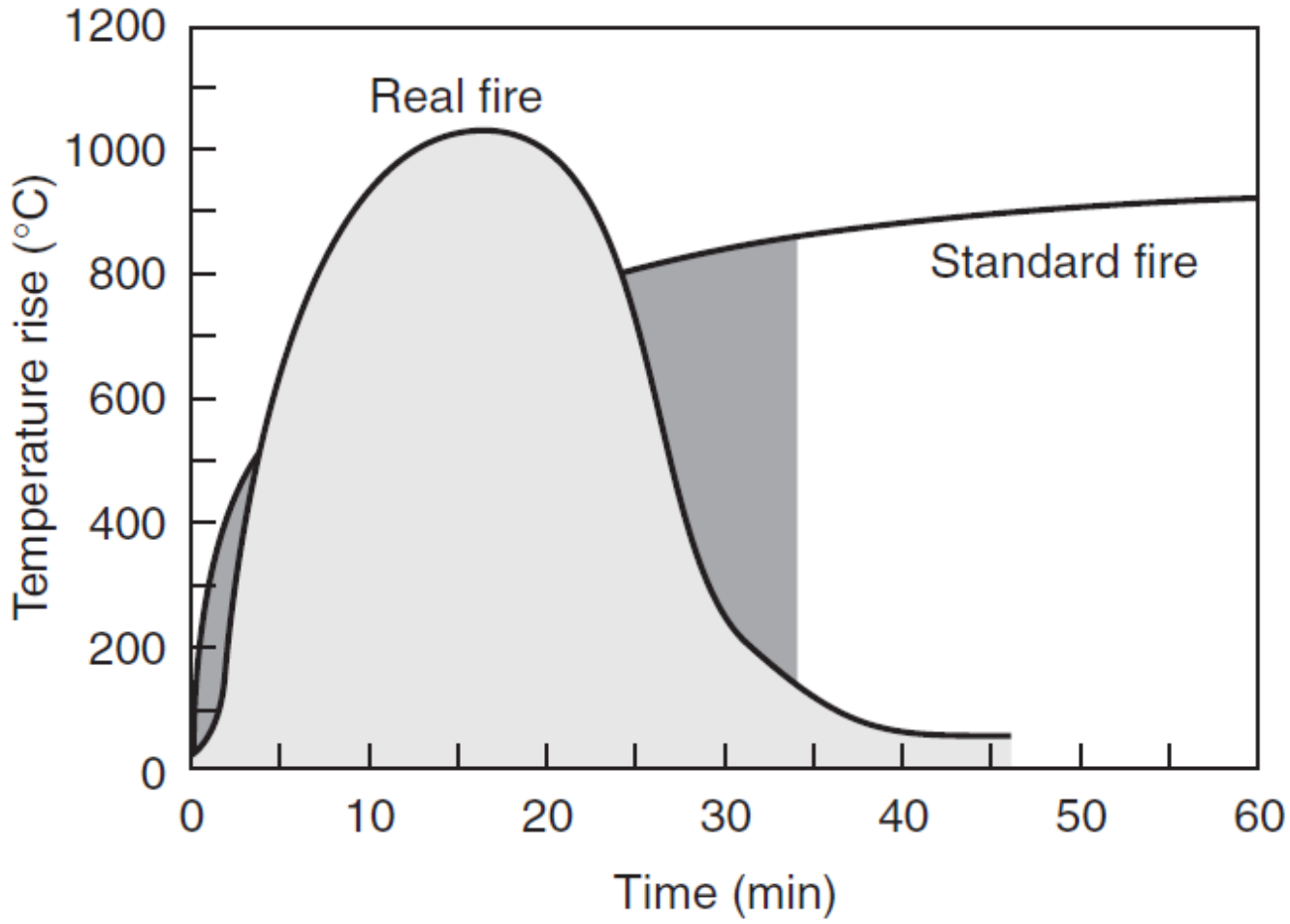




Source: GryfitLab Poland

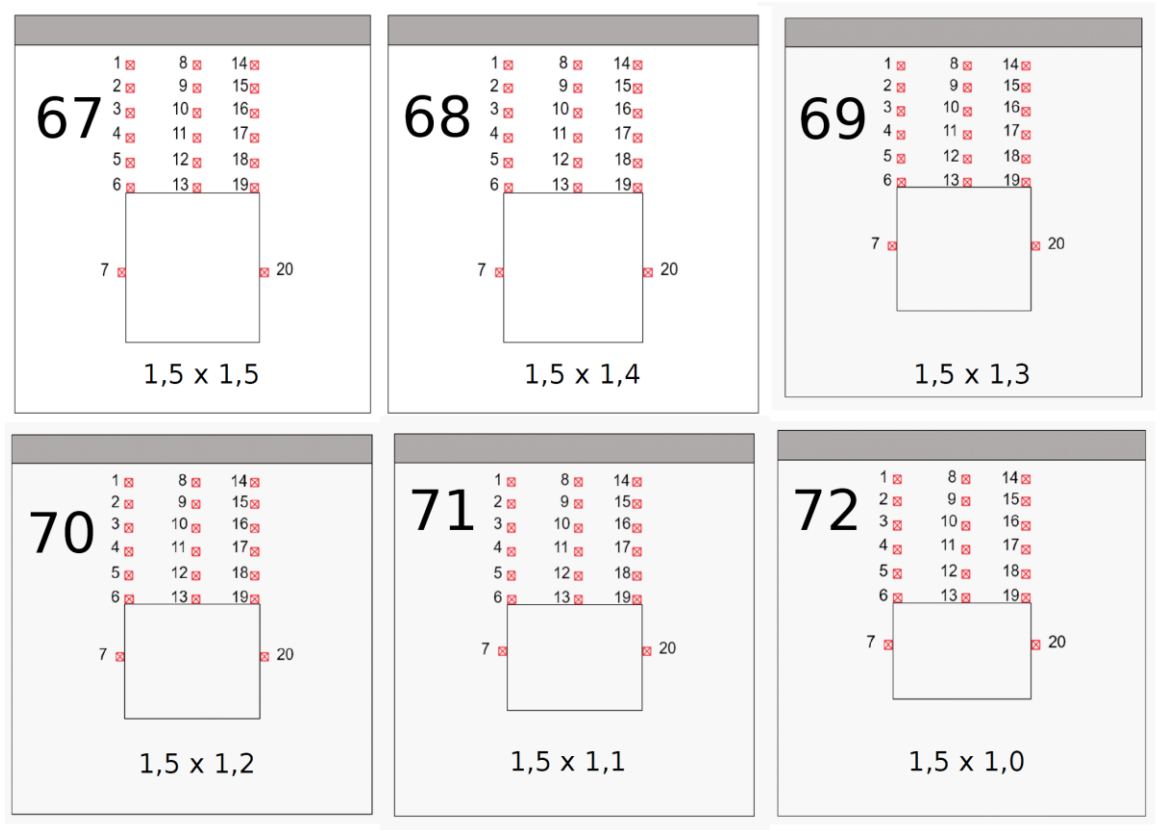
Source: https://heissbemessung.net/

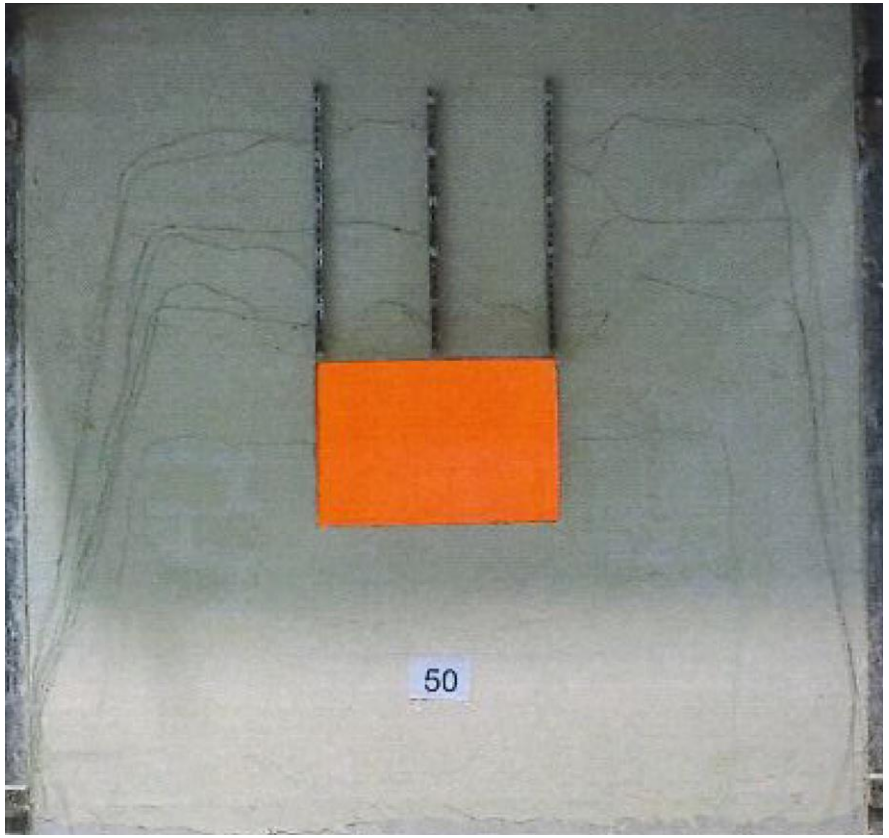
Ingberg's Equal-Area Concept



Source: Fire Protection Handbook, NFPA, 2008

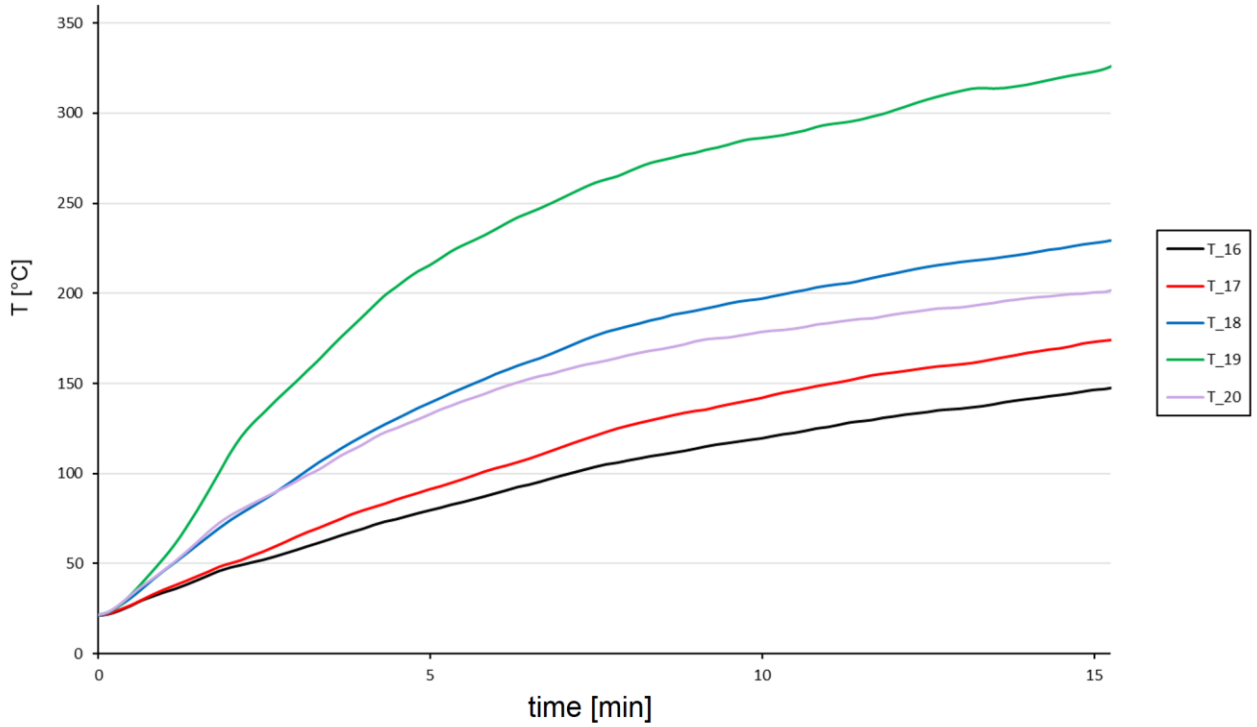
Test assumptions

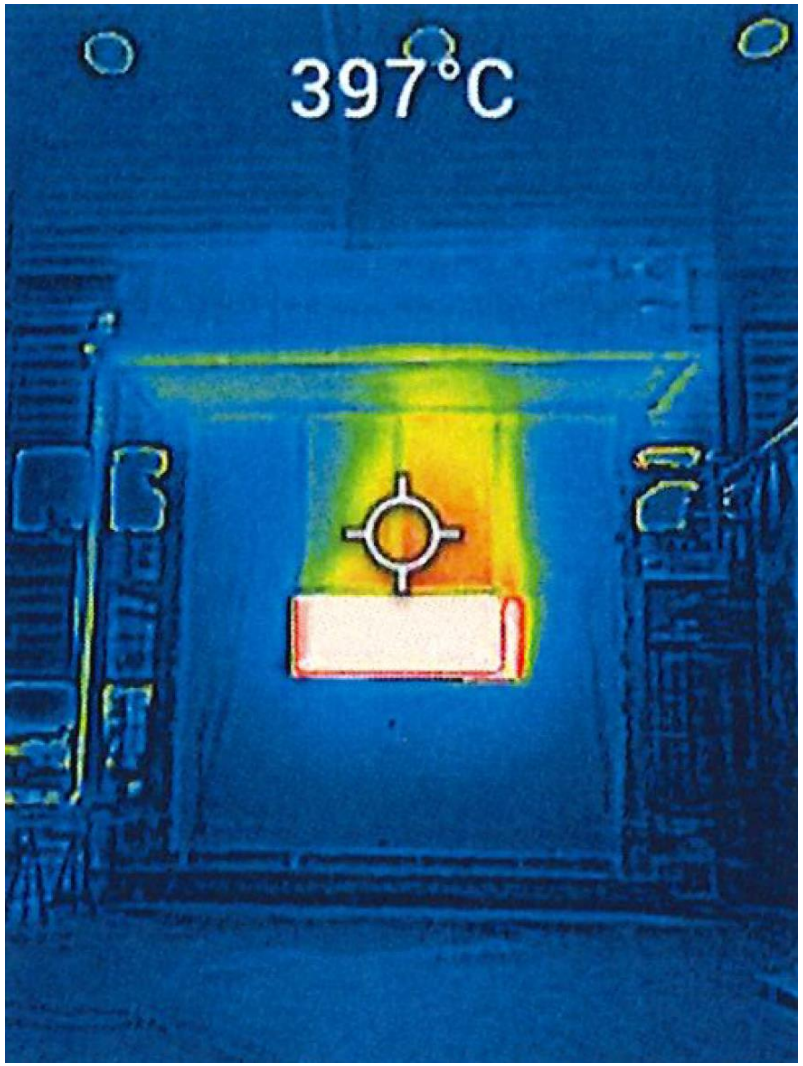




Source: Own study

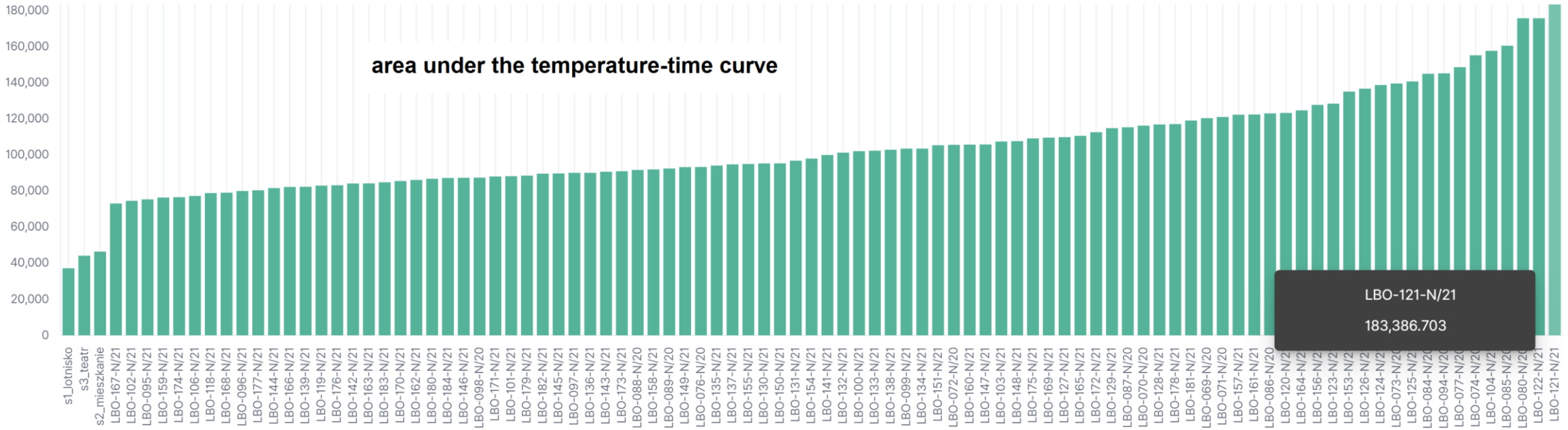
Results of the tests





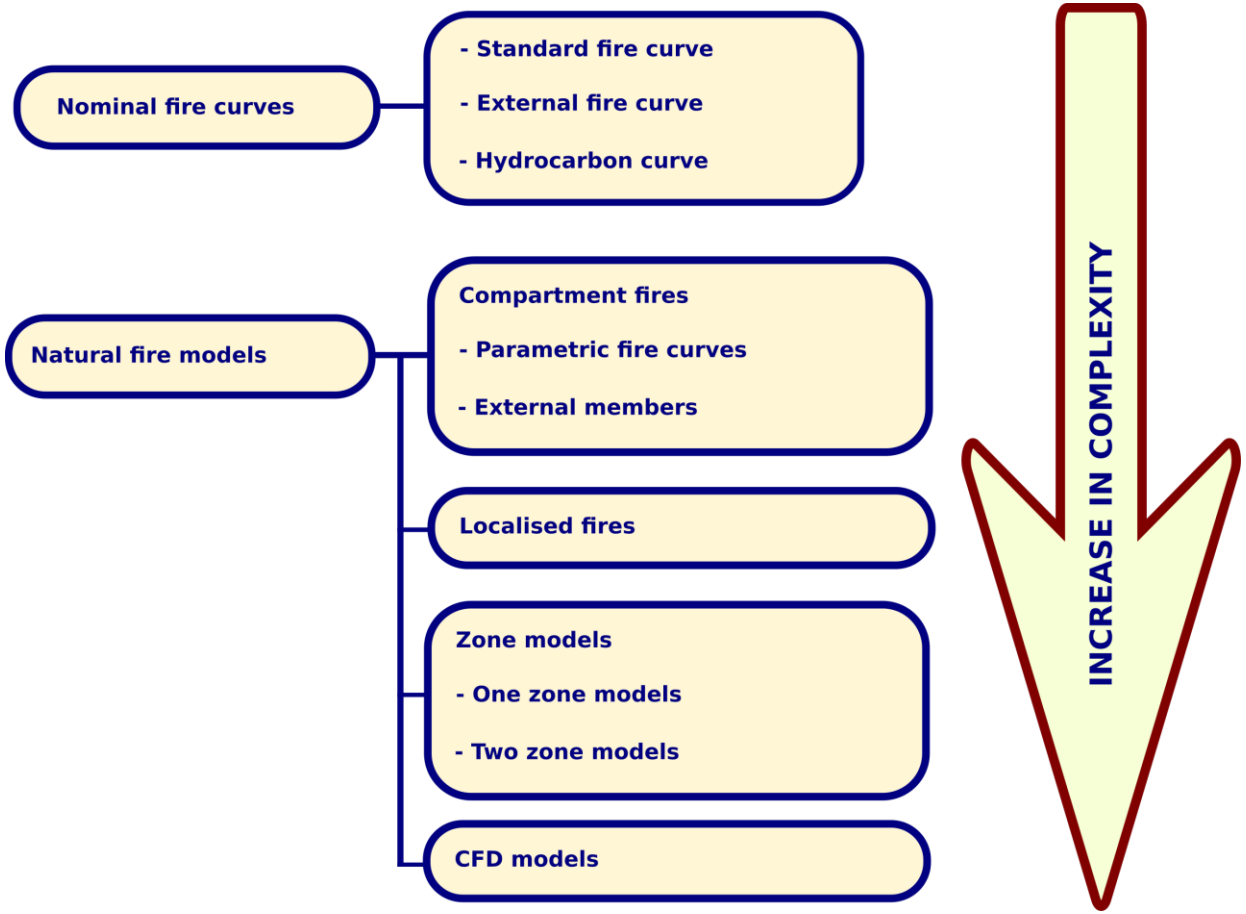
Source: Own study

Data analysis



Source: Own study

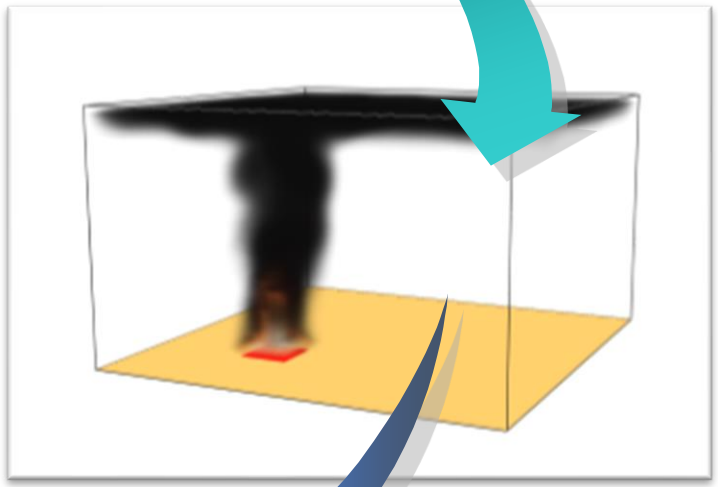
Natural fire models



Source: Eurocode 1: Actions onstructures - Part 1-2: General actions - Actions onstructures exposed to fire

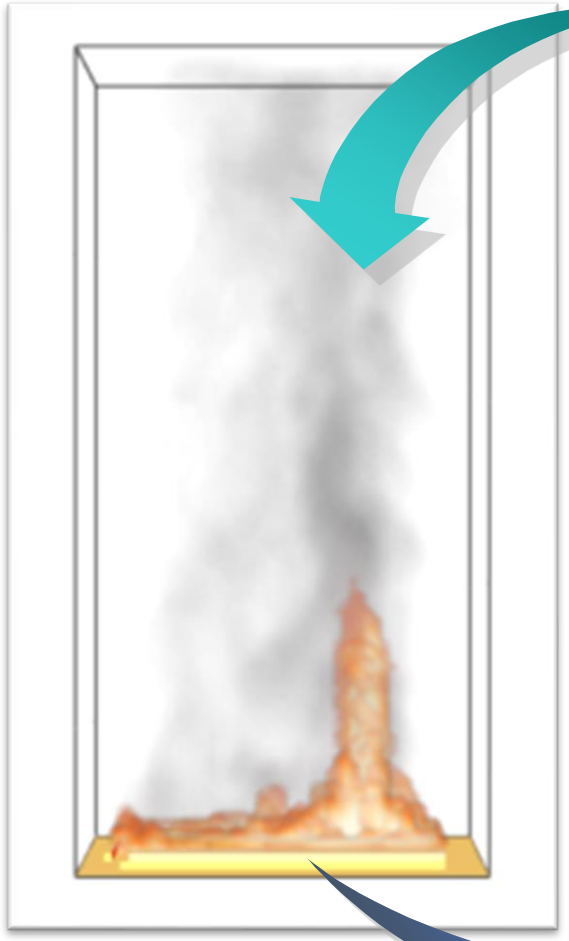
HRR modeling

Simple Pyrolysis Model



HRR prescribed by the user

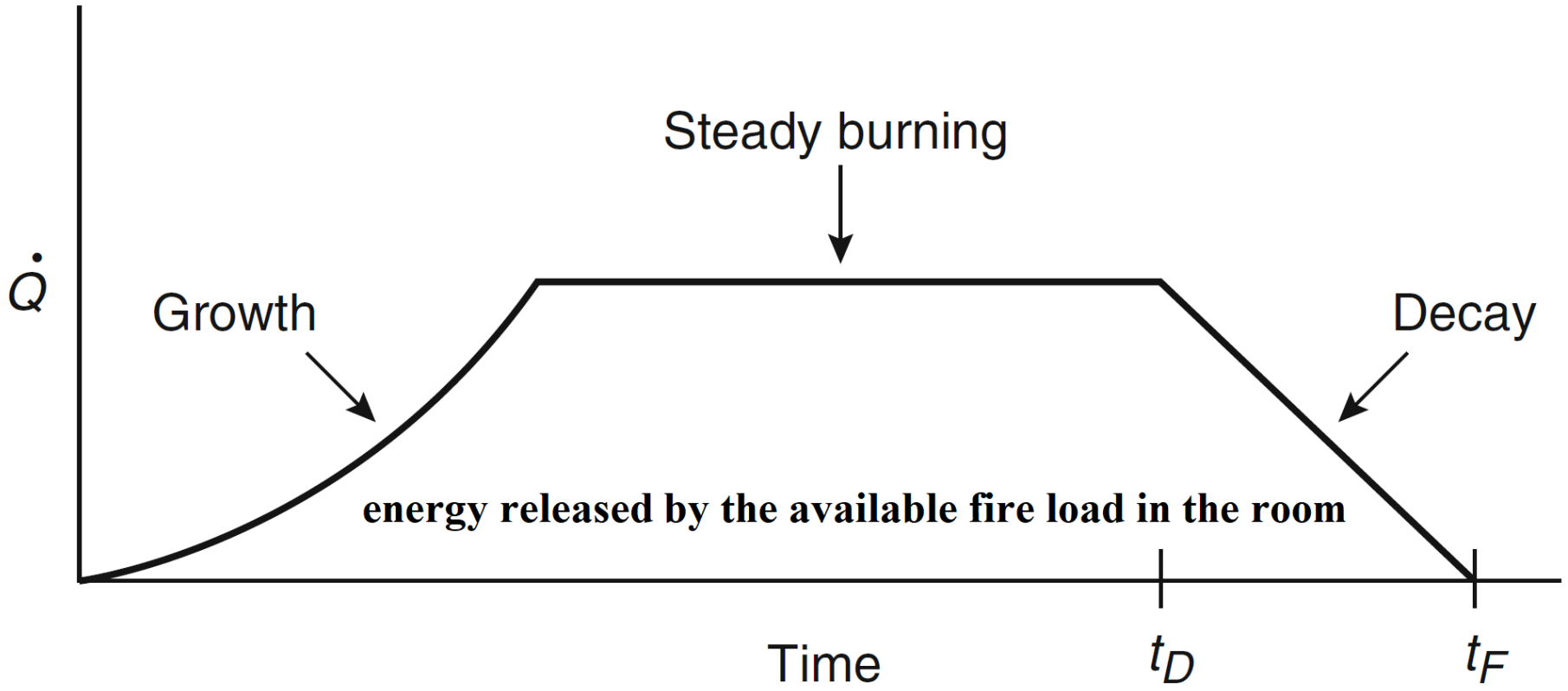
Complex Pyrolysis Model



HRR predicted by the model

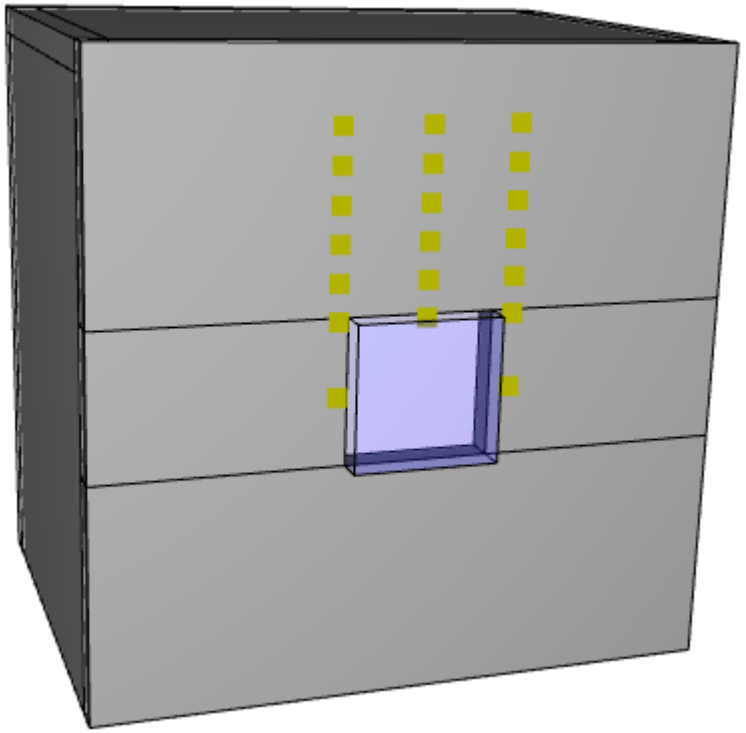
Source: own study

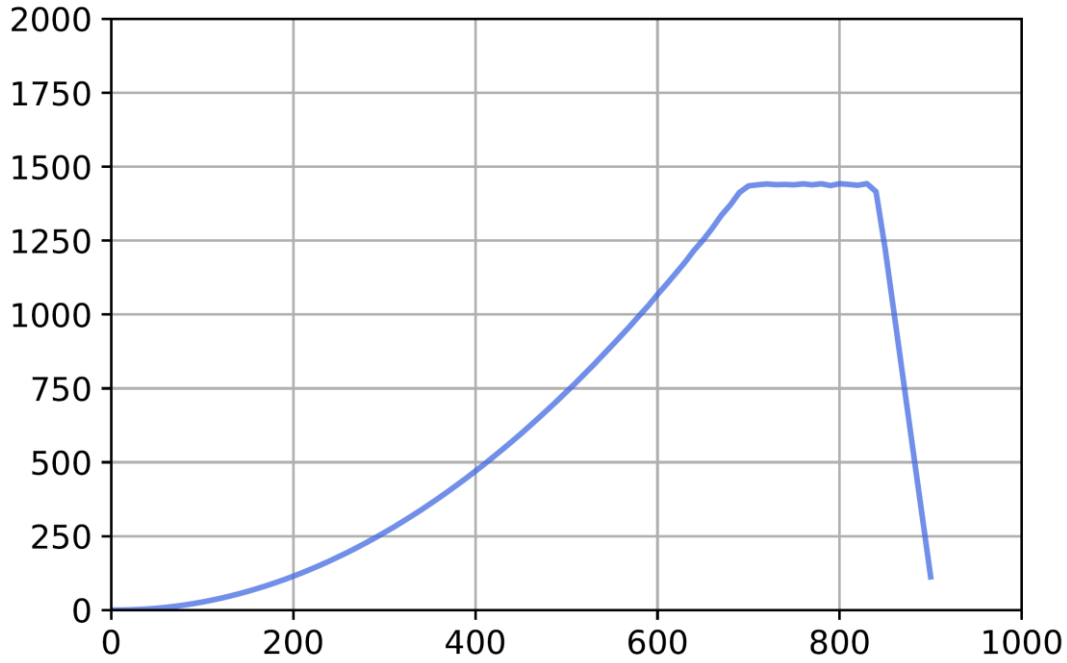
Simple design fire curve



Source: SFPE Handbook of Fire Protection Engineering, 2016

CFD simulations





Source: own study

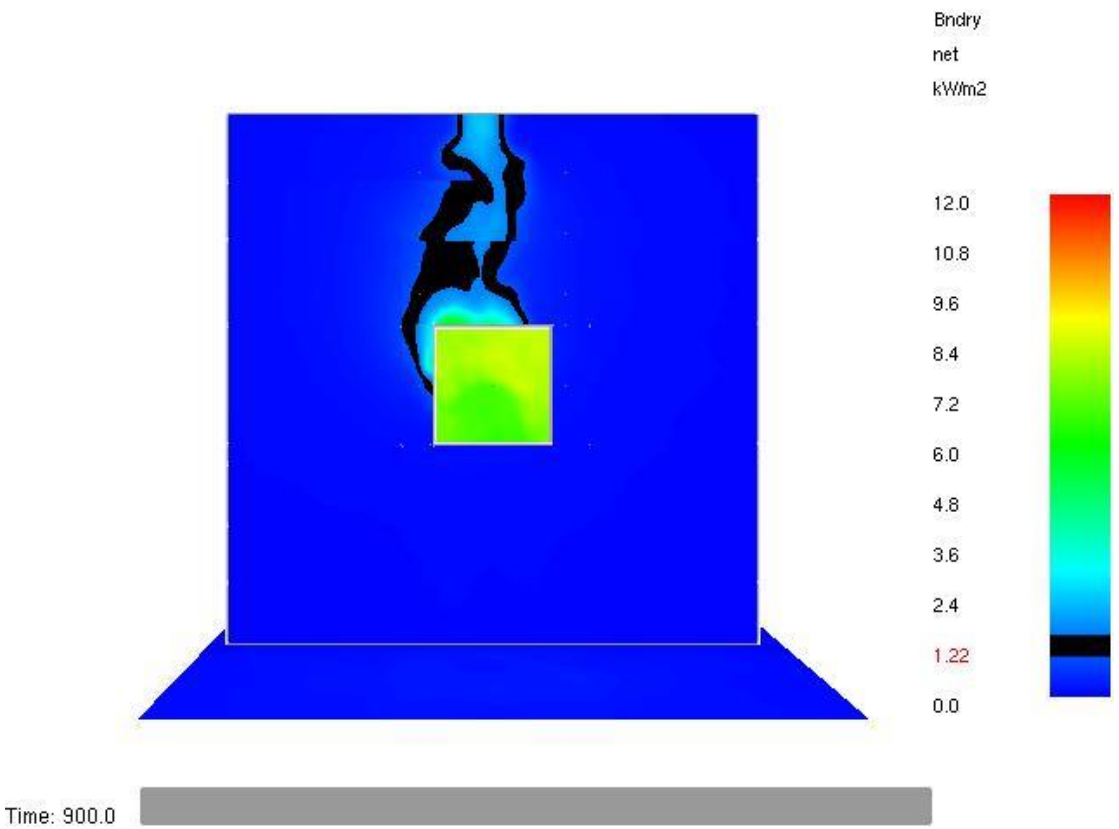
Different fire curves

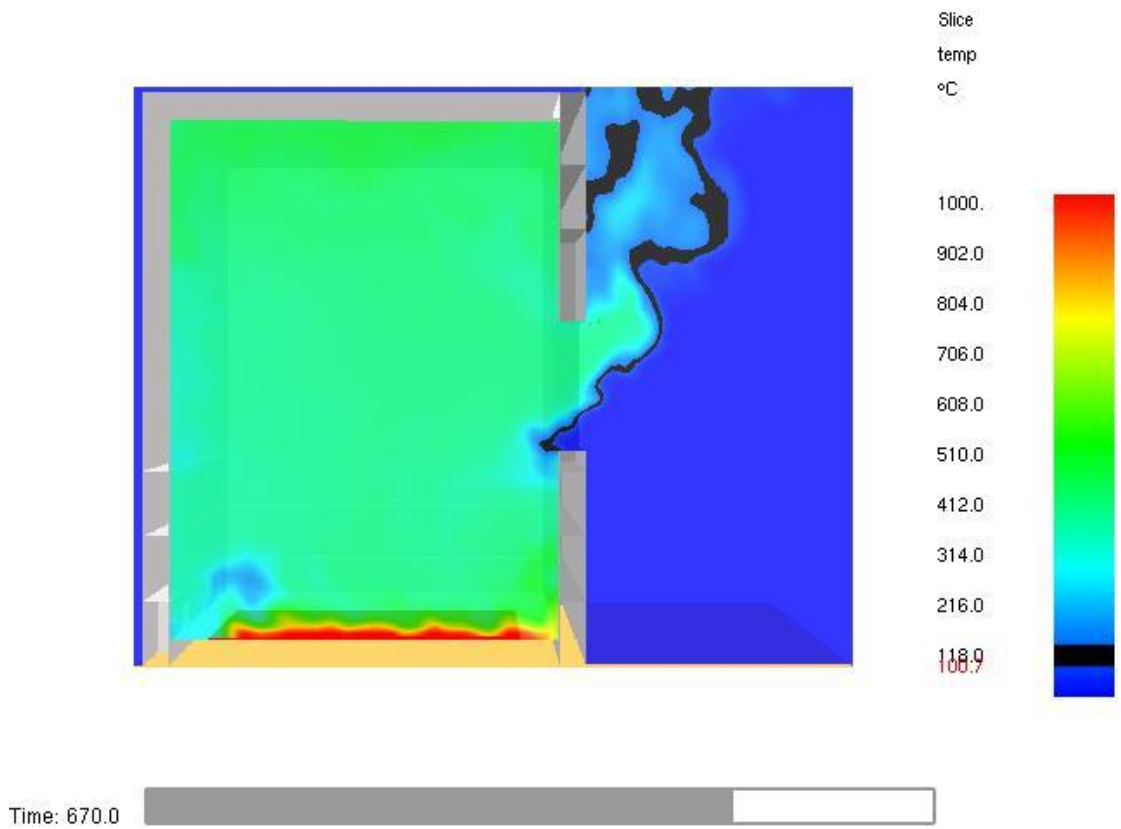
Growth rate	t_{1000} (s)	Typical real fires
Slow	600	Densely packed wood products
Medium	300	Solid wood furniture (desks) Individual furniture items with small amounts of plastic
Fast	150	High stacked wood pallets Cartons on pallets Some upholstered furniture
Ultrafast	75	Upholstered furniture High stacked plastic materials Thin wood furniture (wardrobes)

Variable fire load density [MJ/m^2]		
Occupancy	Mean	Standard
Dwelling	780	234
Hospital (room)	230	69
Hotel (room)	310	93
Library	1500	450
Office	420	126
Classroom of a school	285	85.5
Shopping centre	600	180
Theatre (cinema)	300	90
Transport (public space)	100	30

Source: SFPE Handbook of Fire Protection Engineering, 2016

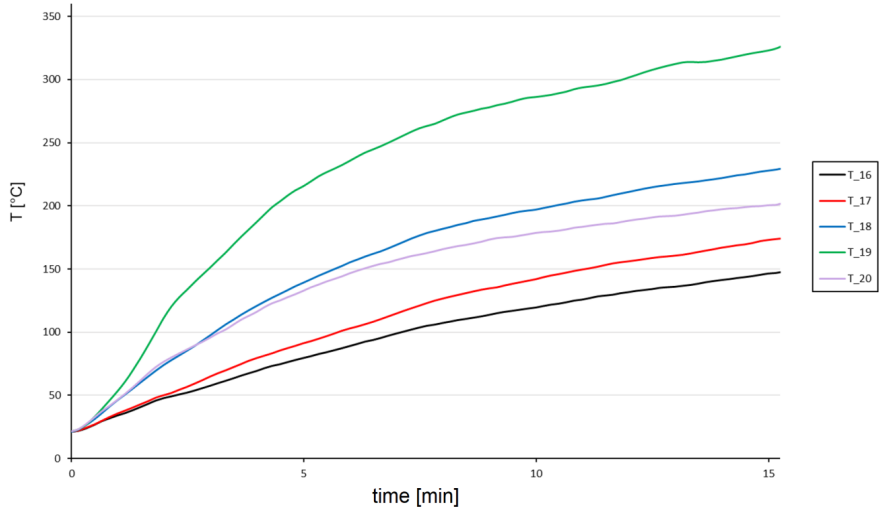
Simulations results

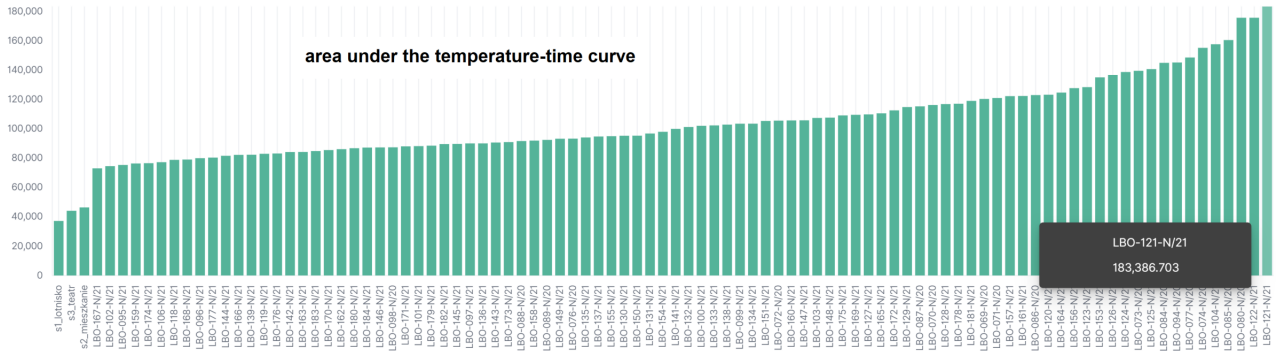




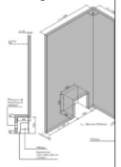
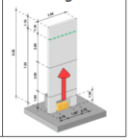
Source: own study

Other test methods





Source: own study

Country	Test method	Scope of test method	Field of application	Scale	Configura-tion
Germany Switzerland	DIN 4102-20	Complementary test of the cladding systems (each part of the system has to be low flammable according to DIN 4102-1 or DIN EN 13501-1) for classifica-tion as low flammable as a system.	Complementary test of the clad-ding systems (each part of the system has to be low flammable ac-cording to DIN 4102-1 or EN 13501-1) for classification as low flammable as a system.	Medium scale	Two wings (i.e. corner) configuration 
United Kingdom (England, Scotland, Wales and Northern Ireland) Republic of Ireland	BS 8414 series	Part 1 - Fire performance of external cladding systems. Test method for non-load-bearing external cladding systems applied to the masonry face of a building. Part 2 - Fire performance of external cladding systems. Test method for non-load-bearing external cladding systems fixed to and supported by a structural steel frame.	Applicable to the system as tested.	Large scale	Right angle, return wall 
Poland	PN-B-02867	Determination of fire behavior of façades without window. The test philosophy is to determine the heat and flames influence contribution of the faça-de's combustion on the effect of exposure of standard fire source.	All façade systems	Medium scale	Single vertical wall without openings 
Switzerland	Prüfbestim-mung für Aus-senwand-be-kleidungs-systeme	The test method is used for the evaluation and proof of the fire behavior of external wall covering systems on the original scale, when exposed to fire from a simulated apart-ment fire with flames	The test method is applicable to linings and surface coatings (paints, plasters, etc.) used on exterior walls. Included are elements with limi-ted application area, such as de-	Large scale	Single vertical wall, no wing 

A THIEF, though taking everything away, at least four walls shall allow to stay, but the FIRE itself shall leave nothing behind…

THANK YOU !

Andrzej Krauze

mail: akrauze@sgsp.edu.pl

tel.: 510 288 172

Andrzej Krauze

mail: akrauze@sgsp.edu.pl

tel.: 510 288 172