FIRE STOPS IN BUILDINGS

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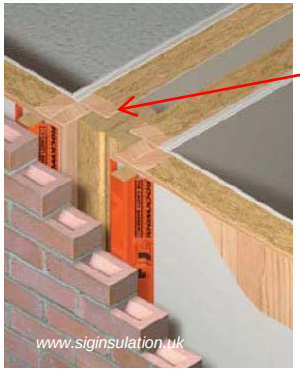
Stockholm 8 Maj 2018

Research Institutes of Sweden

Fire Research

Modular wooden buildings

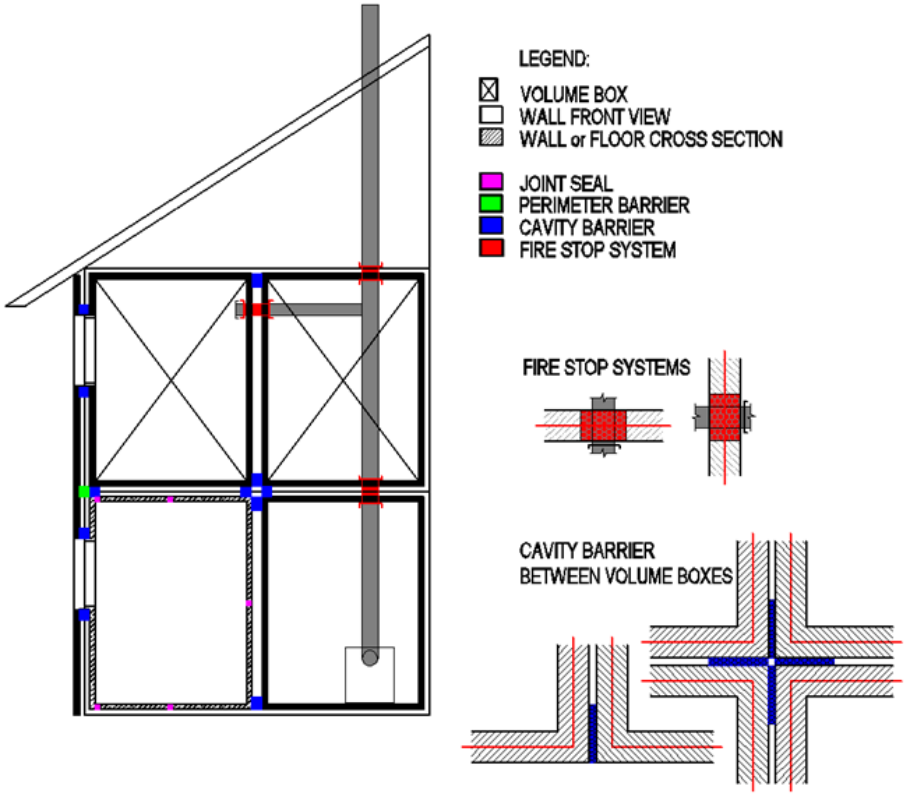


Fire stops

Modular wooden buildings

Cavity barriers

BF 14-004
Fire Stops in Buildings



Fire stops for combustible materials in cavities

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Fire Stops in Buildings

This project is the result of a study that aimed to:

- Develop a robust testing method for cavity barriers for cavities with combustible materials within walls, floors and other elements in buildings.

- Provide guidelines for the materials, installation, positioning, detailing and location of the cavity barriers.

Reference group

BF 14-004
Fire Stops in Buildings

Anders Johansson	Boverket
Viktor Wahlsten	Brandskyddslaget
Håkan Pettersson	LF Västerbotten
Matilda Svensson	MSB
Johan Andersson	SP Fire Research
Robert Jansson McNamee	SP Fire Research
Daniel Brandon	SP Hållbar Samhällsbyggnad
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Alar Just	SP Hållbar Samhällsbyggnad

Review of real cavity fires

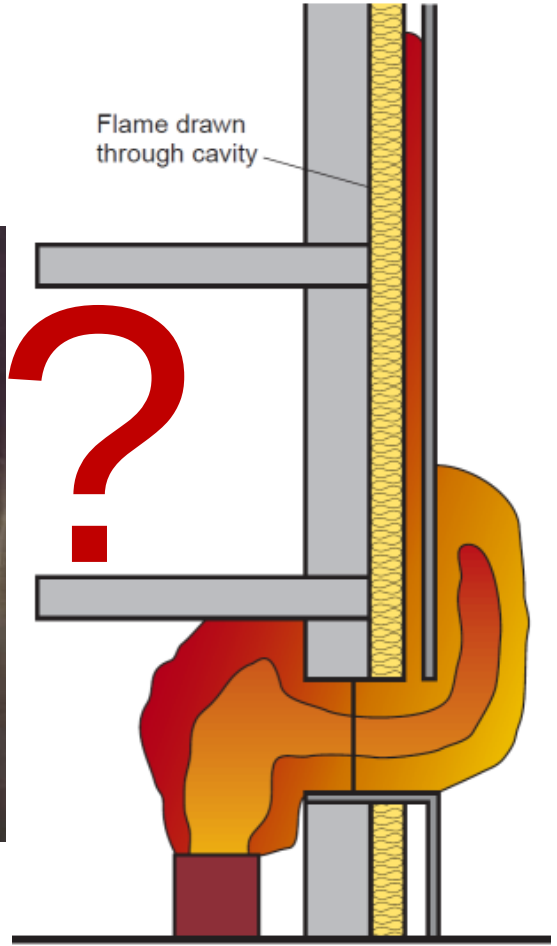
For an assessment of weaknesses of the preliminary test method a review of real cavity fires is performed.

- Luleå, Klintbacken in 2013 (Umeå Kommun Brandförsvar och Säkerhet, 2013; Ostman and Stehn, 2014)
- Umeå, Ålidhem in 2008 (Umeå Kommun Brandförsvar och Säkerhet, 2009
- Full scale fire test by BRE on a 6-storey timber framed building in a former airship hangar in Cardington (Lennon *et al.*, 2000).

High-damage fire in Luleå

- *Fire spread from a pan to the cabin above the stove*
- *Combustion of the flexible hose caused rapid heating of the air channel*
- *Combustible material in the attic ignited and the fire spread to the roof structure quickly*
- *40 minutes after the arrival of the fire service large parts of the roof structure collapsed*
- *After the fire cooled down, a fire spread through cavities was discovered*
- *It took 17 hours to extinguish the fire completely*

Fire stops for combustible materials in cavities



Review of real cavity fires

The three fires discussed above have the following in common (among other aspects):

- The fire spread through cavities in which the airflow may have been limited.
- The cavity contained combustible materials.
- The cavity fires outlasted the compartment fires by several hours.
- The cavity fires led to re-ignition of compartments after several hours.
- The fires were difficult to extinguish and led to high damages.

Review of real cavity fires

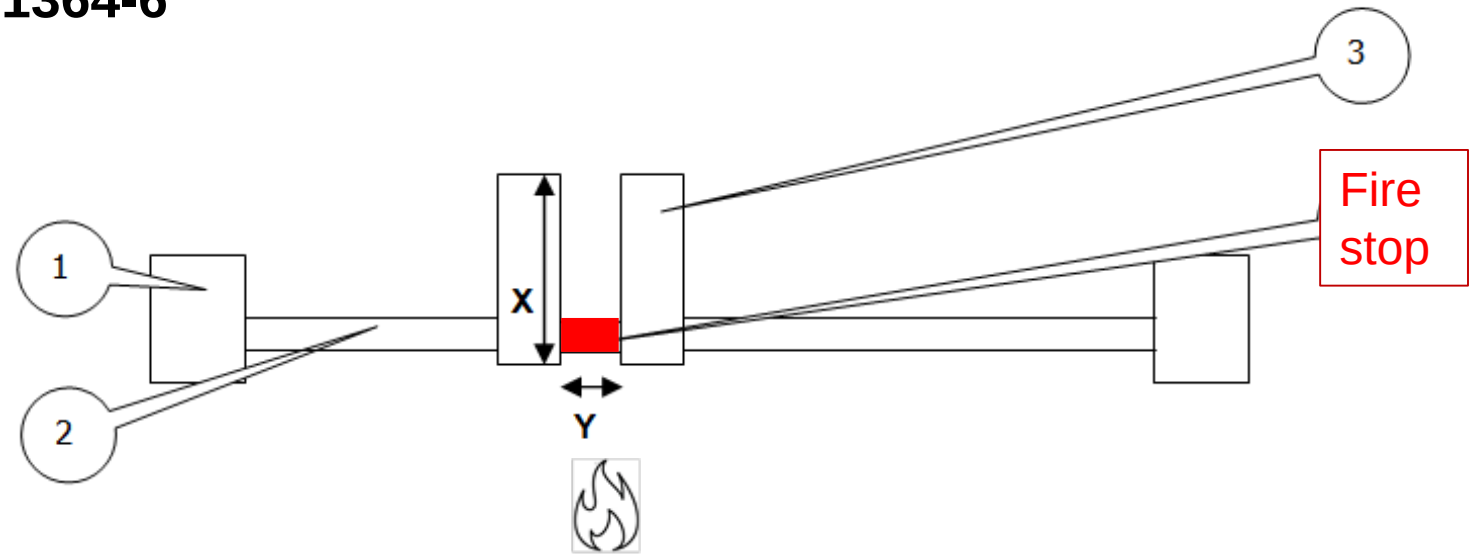
A method to assess cavity barriers should include

- a period after a fully developed fire,
- combustible materials within the cavity and
- potential heating of the air within a cavity.

Using a revised test method should lead to more reliable guidance for the use of cavity barriers.

Testing standard

EN 1364-6



Gas concrete, dense concrete, masonry, calcium silicate board or plasterboard.
X≤500 mm.

Model scale fire tests

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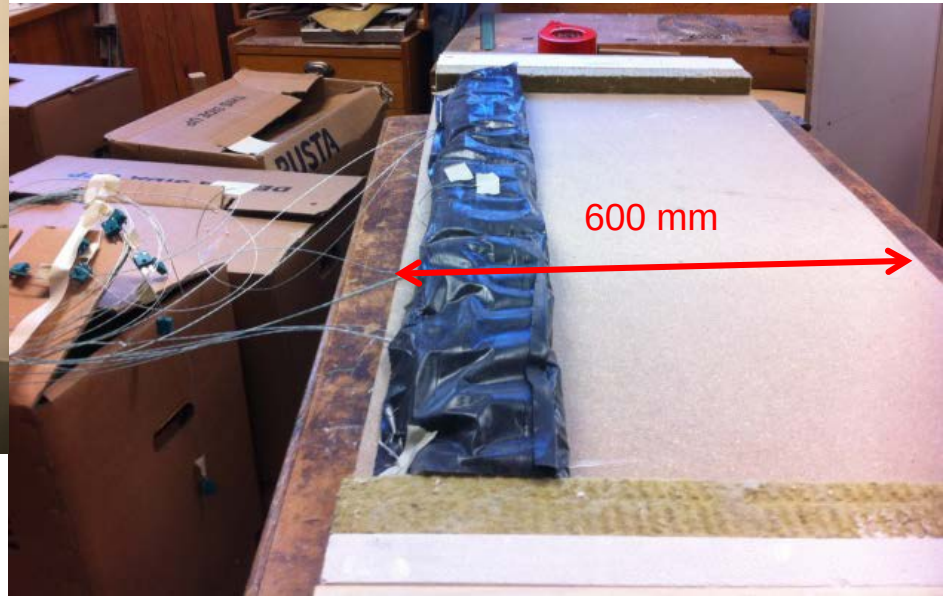
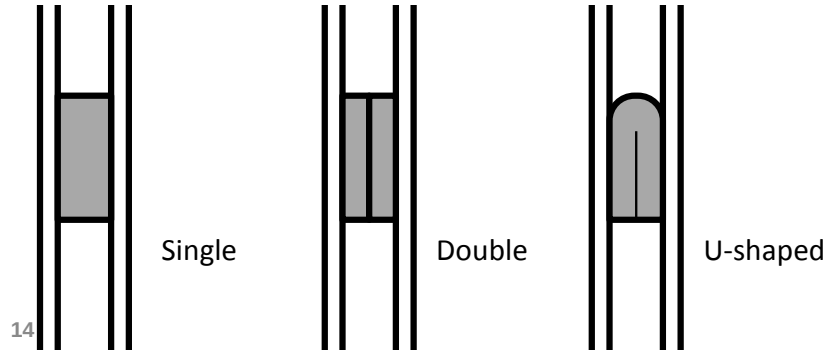
Test series 1 – preliminary studies (1 h in standard fire)

Test series 2 – advanced studies (1 h in standard fire + 3 h cooling phases)

Test series 3 – tests with joints (1 h in standard fire + 1 h cooling phases)

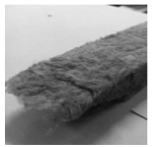
TEST SERIES 1

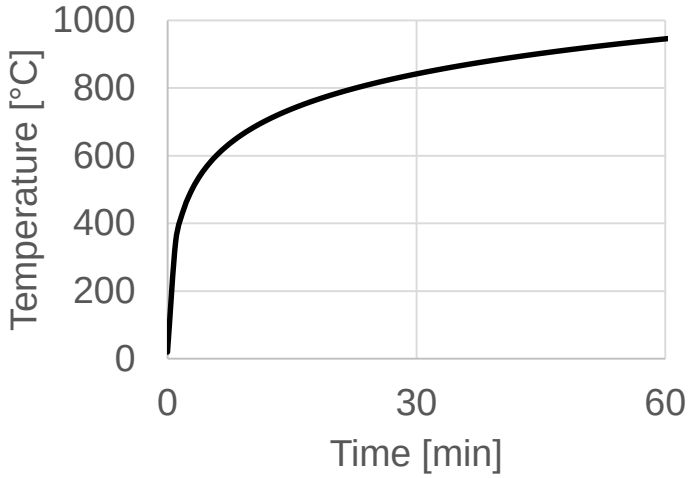




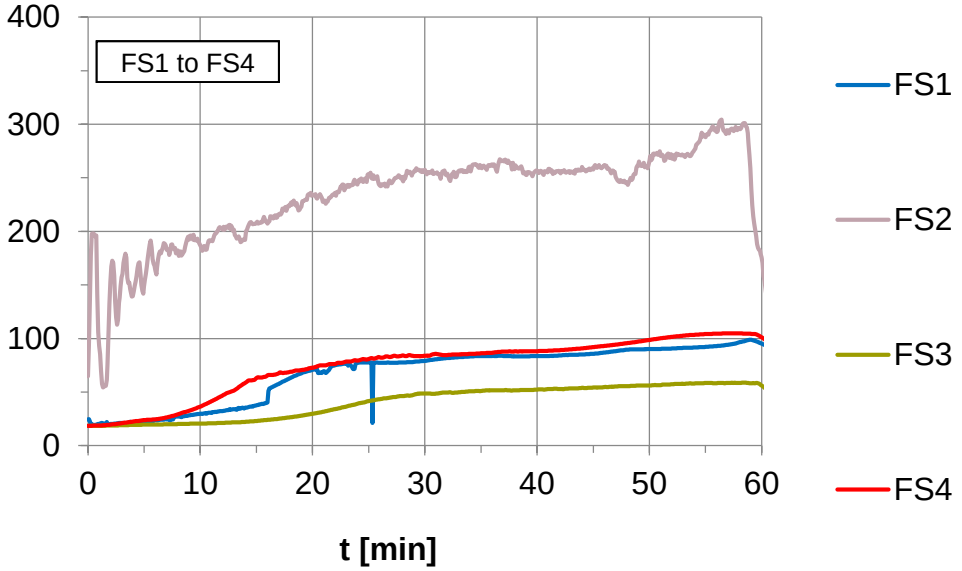
Particle boards and plywood as cavity materials.

TEST SERIES 1

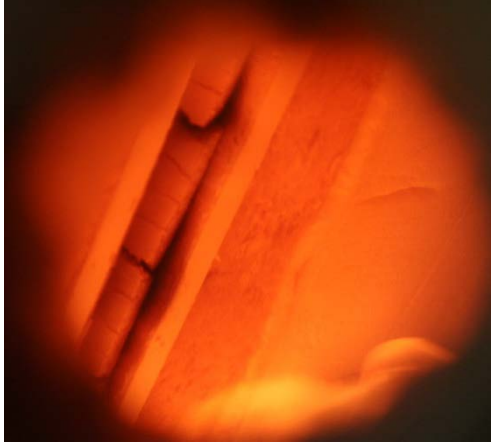
Specimen	FS1	FS2	FS3	FS4
Cavity barrier	Plastic covered HTE mineral wool	Stone wool	Plastic covered glass wool	Plastic covered HTE mineral wool
Dimensions, b x h [mm]	15x120	65x25	50x160	35x95
Appearance				
Unpressed density [kg/m³]	20	28	20	20
U-shape (U) / single (S) / double (D)	U	S	U	D



T [°C]

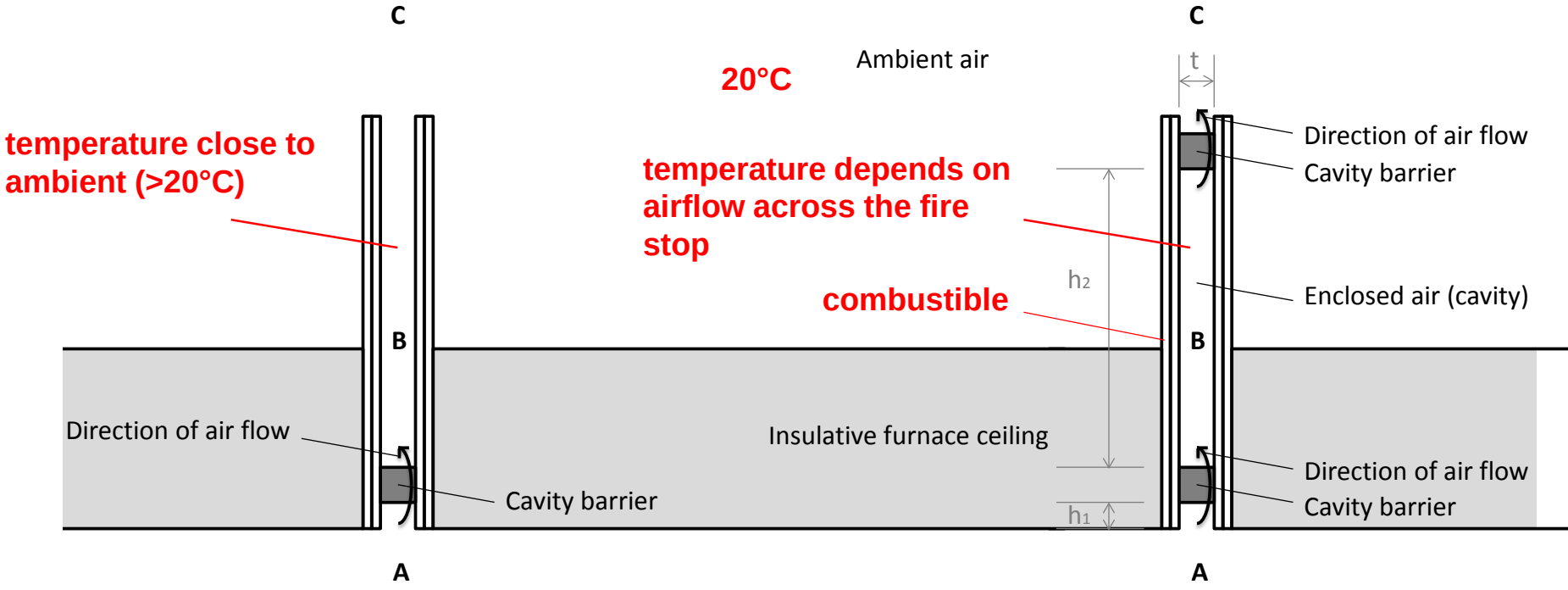


The cavity barrier is considered successful if the temperature on the unexposed side remains lower than 300°C.

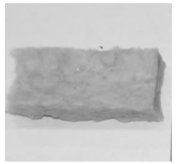


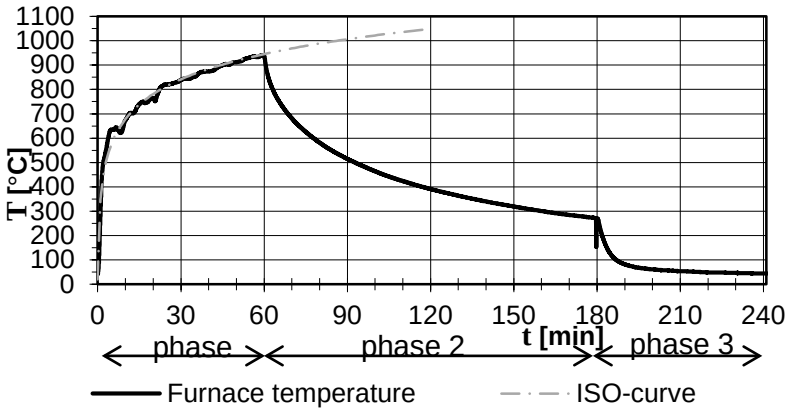
Model scale fire tests

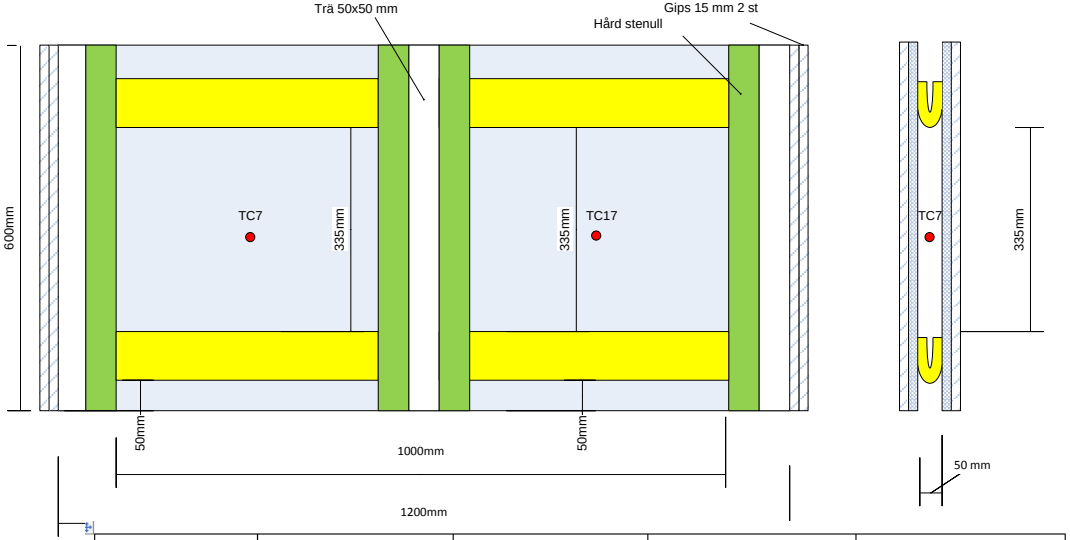
Fire stops for combustible materials in cavities

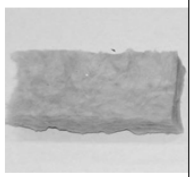
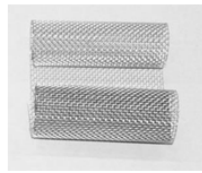


TEST SERIES 2

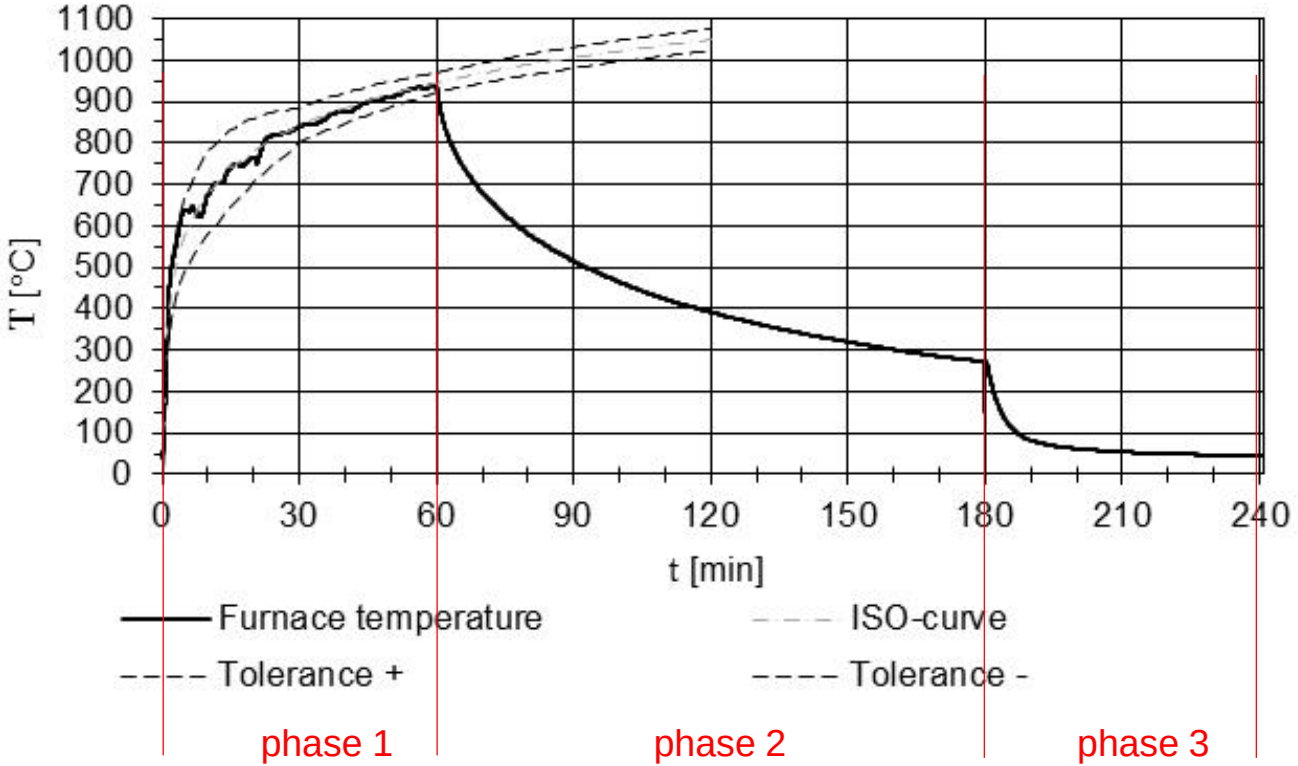
Specimen	FS5.1 & FS6.1	FS5.2	FS6.2
Cavity barrier	Plastic covered HTE mineral wool	HTE mineral wool	Plastic covered glass wool
Dimensions [mm]	30x95	30x95	50x160
Appearance			
Unpressed density [kg/m³]	21	22	26





Specimen	FS7.1	FS7.2	FS8.1	FS8.2
Cavity barrier	Plastic covered glass wool	Glass wool	Plastic covered Intumescent (ventilated cavity at room temperature)	Intumescent in rolled wire mesh* (ventilated cavity at room temperature)
Dimensions [mm]	20x60	20x100	4x73	roll: 40Ø intumescent: 4x44
Appearance				
Unpressed density [kg/m³]	20	26	650	1310

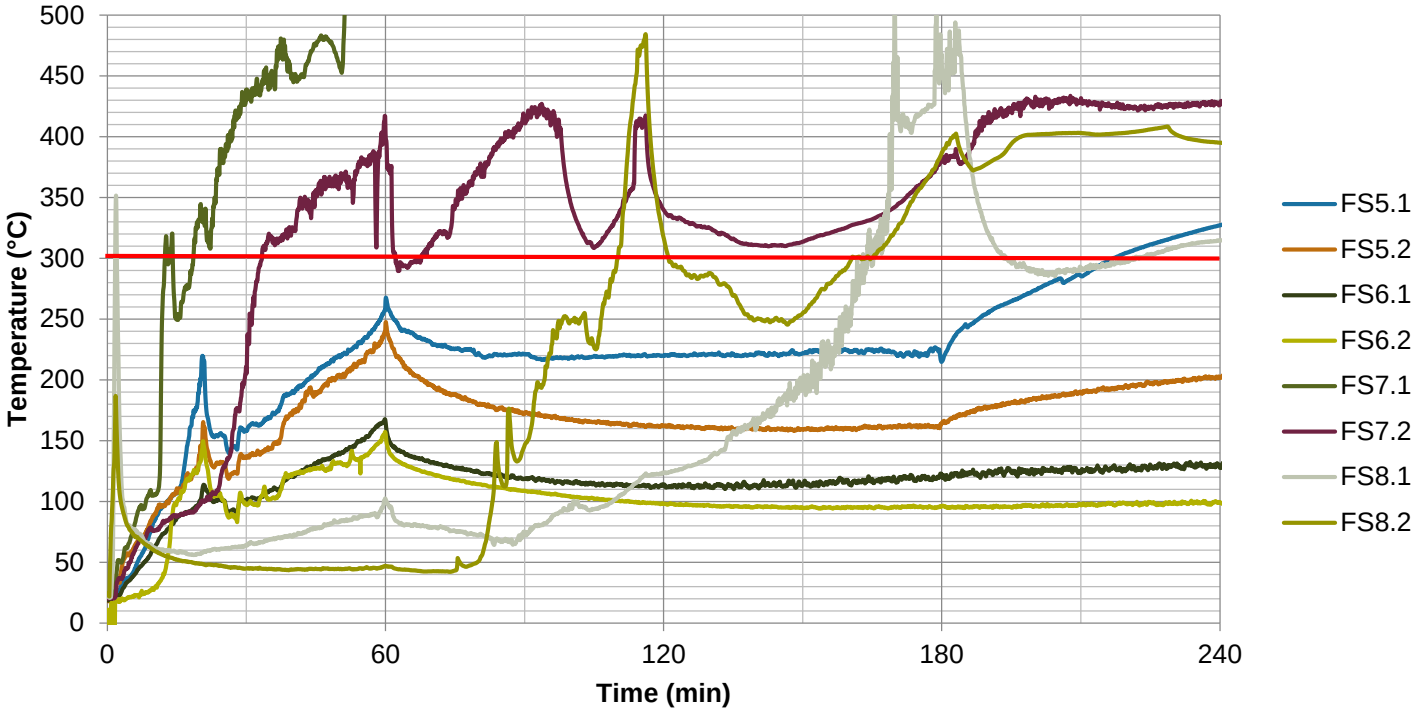
Fire stops for combustible materials in cavities



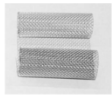
Failure criteria

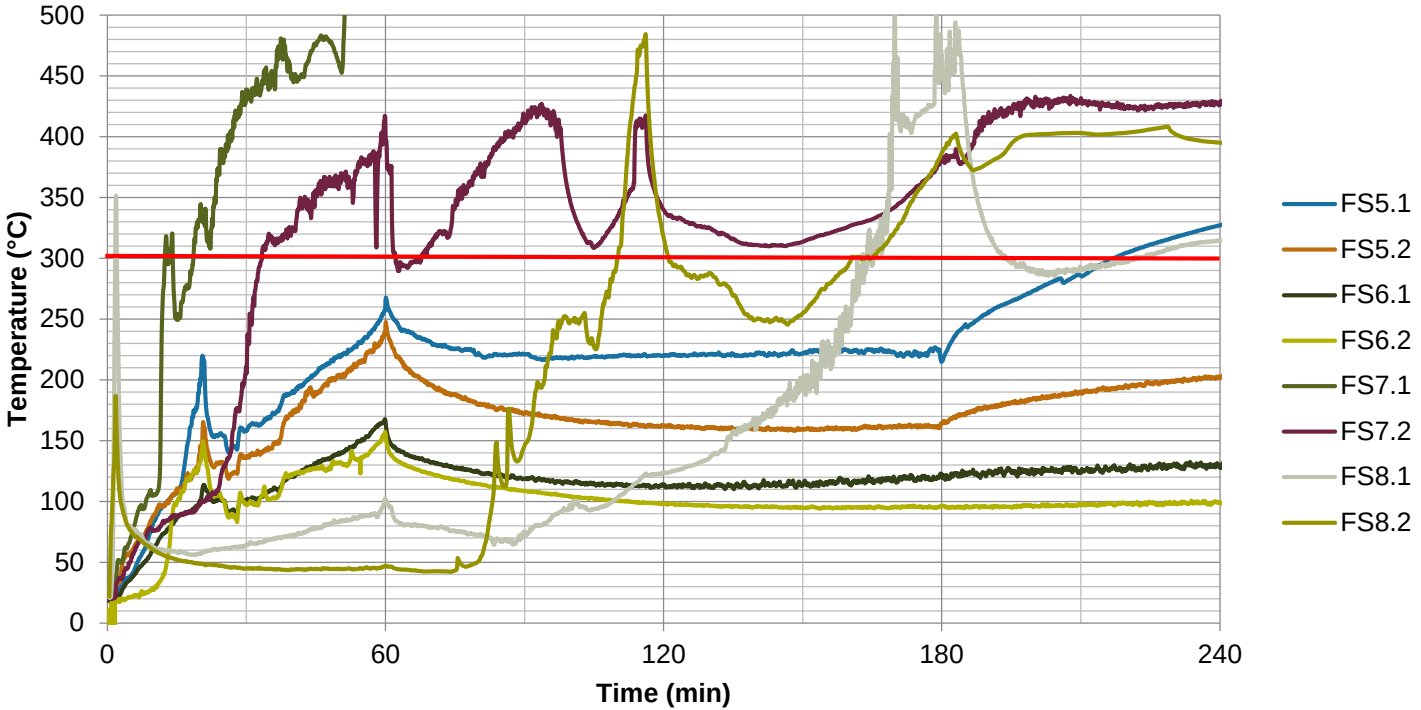
Sustained temperature over 300°C cannot be accepted.
Any sign of sustained combustion within the cavity barriers cannot be accepted. Wood based products generally have a combustion temperature of approximately 300°C.

Therefore, a temperature increase of 10°C or more is considered unacceptable.
An increase of temperature in the cavity while increasing the oxygen content by buoyancy driven flow indicates that there is combustion in the cavity.



Specimen	FS5.1 & FS6.1	FS5.2	FS6.2
Cavity barrier	Plastic covered HTE mineral wool	HTE mineral wool	Plastic covered glass wool
Dimensions [mm]	30x95	30x95	50x160
Appearance			
Unpressed density [kg/m³]	21	22	26

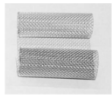
Specimen	FS7.1	FS7.2	FS8.1	FS8.2
Cavity barrier	Plastic covered glass wool	Glass wool	Plastic covered Intumescent (ventilated cavity at room temperature)	Intumescent in rolled wire mesh* (ventilated cavity at room temperature)
Dimensions [mm]	20x60	20x100	4x73	roll: 40Ø intumescent: 4x44
Appearance				
Unpressed density [kg/m³]	20	26	650	1310

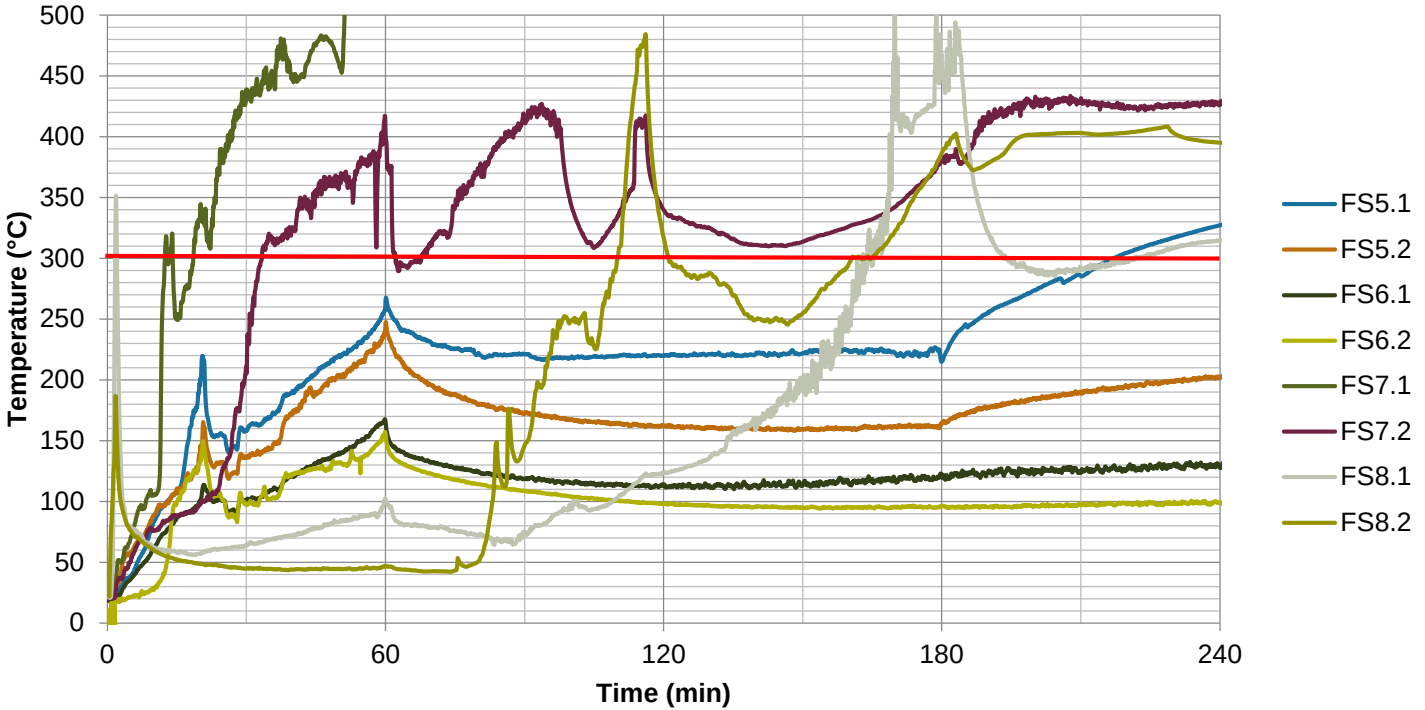


The curves corresponding to closed cavities (all curves except for FS8.1 & FS8.2) showed a large variation.

FS5.1, FS7.1, FS7.2, FS8.1 and FS8.2 failed the test (T> 300°C).

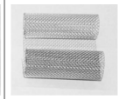
Specimen	FS5.1 & FS6.1	FS5.2	FS6.2
Cavity barrier	Plastic covered HTE mineral wool	HTE mineral wool	Plastic covered glass wool
Dimensions [mm]	30x95	30x95	50x160
Appearance			
Unpressed density [kg/m³]	21	22	26

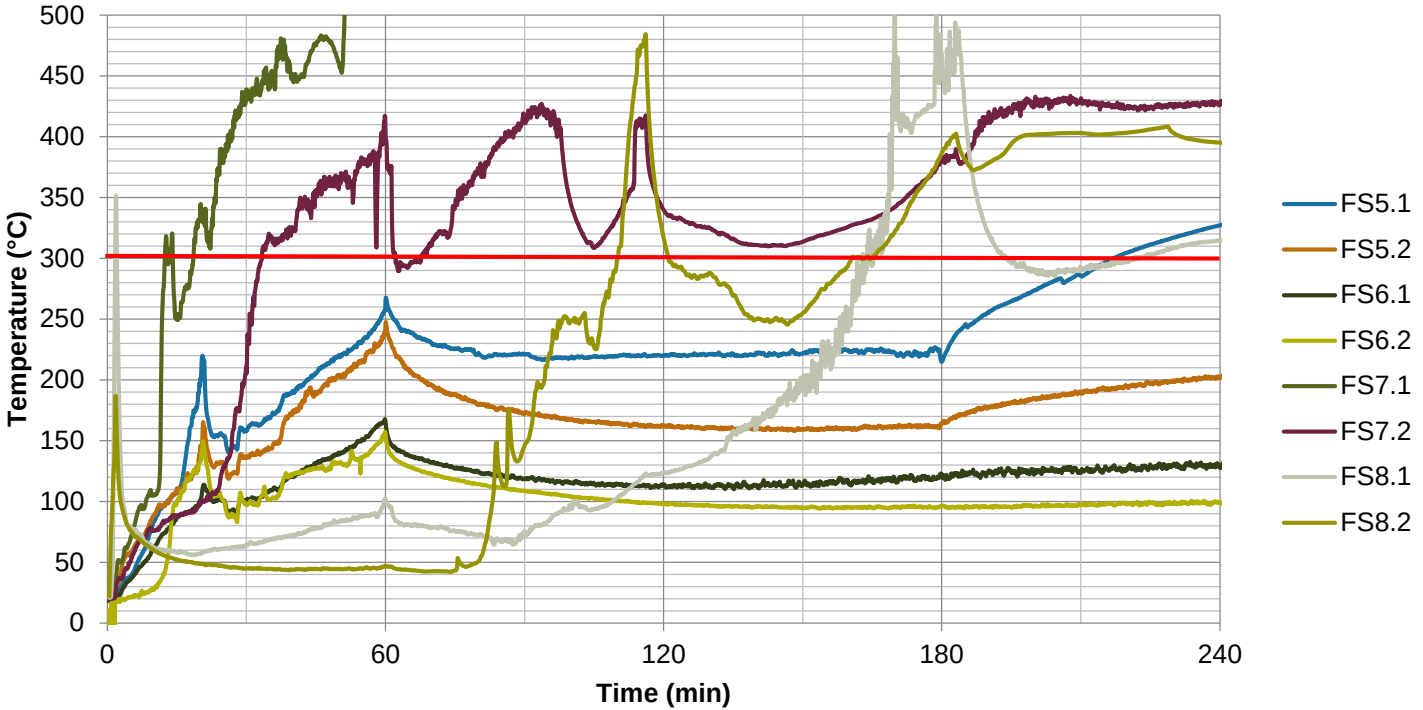
Specimen	FS7.1	FS7.2	FS8.1	FS8.2
Cavity barrier	Plastic covered glass wool	Glass wool	Plastic covered Intumescent (ventilated cavity at room temperature)	Intumescent in rolled wire mesh* (ventilated cavity at room temperature)
Dimensions [mm]	20x60	20x100	4x73	roll: 40Ø intumescent: 4x44
Appearance				
Unpressed density [kg/m³]	20	26	650	1310



The barriers of specimen FS5.2 and FS6.1 showed a significant temperature increase during Phase 3.

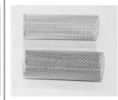
Specimen	FS5.1 & FS6.1	FS5.2	FS6.2
Cavity barrier	Plastic covered HTE mineral wool	HTE mineral wool	Plastic covered glass wool
Dimensions [mm]	30x95	30x95	50x160
Appearance			
Unpressed density [kg/m³]	21	22	26

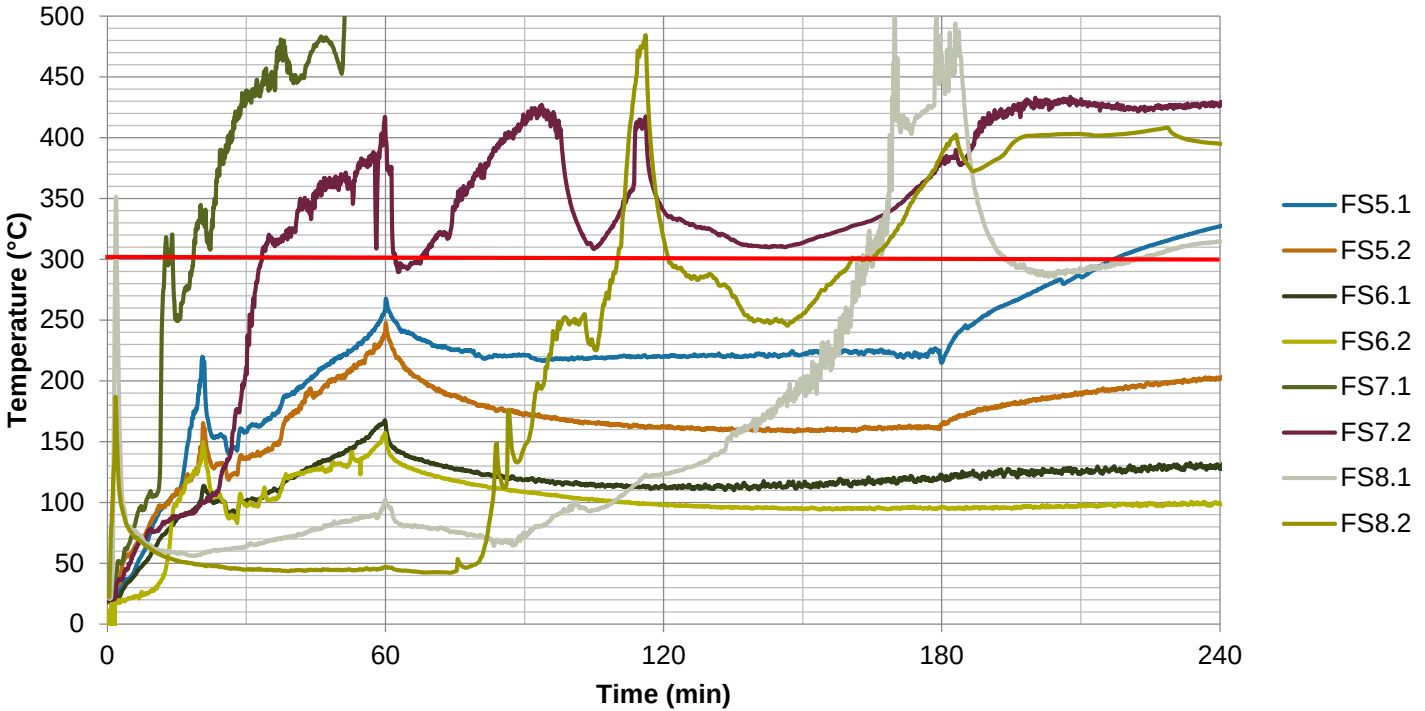
Specimen	FS7.1	FS7.2	FS8.1	FS8.2
Cavity barrier	Plastic covered glass wool	Glass wool	Plastic covered Intumescent (ventilated cavity at room temperature)	Intumescent in rolled wire mesh* (ventilated cavity at room temperature)
Dimensions [mm]	20x60	20x100	4x73	roll: 40Ø intumescent: 4x44
Appearance				
Unpressed density [kg/m³]	20	26	650	1310



FS5.1 and FS6.1 are identical, but show significantly different temperatures. This is caused by, (i) variations in the product, (ii) variation in the mounting or (iii) something related to the chosen test method.

Specimen	FS5.1 & FS6.1	FS5.2	FS6.2
Cavity barrier	Plastic covered HTE mineral wool	HTE mineral wool	Plastic covered glass wool
Dimensions [mm]	30x95	30x95	50x160
Appearance			
Unpressed density [kg/m³]	21	22	26

Specimen	FS7.1	FS7.2	FS8.1	FS8.2
Cavity barrier	Plastic covered glass wool	Glass wool	Plastic covered Intumescent (ventilated cavity at room temperature)	Intumescent in rolled wire mesh* (ventilated cavity at room temperature)
Dimensions [mm]	20x60	20x100	4x73	roll: 40Ø intumescent: 4x44
Appearance				
Unpressed density [kg/m³]	20	26	650	1310



The upper barrier was not fully activated during this period (as a single-barrier test). The applied method should be questioned for ventilated cavities.

Specimen	FS5.1 & FS6.1	FS5.2	FS6.2
Cavity barrier	Plastic covered HTE mineral wool	HTE mineral wool	Plastic covered glass wool
Dimensions [mm]	30x95	30x95	50x160
Appearance			
Unpressed density [kg/m³]	21	22	26

Specimen	FS7.1	FS7.2	FS8.1	FS8.2
Cavity barrier	Plastic covered glass wool	Glass wool	Plastic covered Intumescent (ventilated cavity at room temperature)	Intumescent in rolled wire mesh* (ventilated cavity at room temperature)
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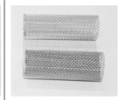
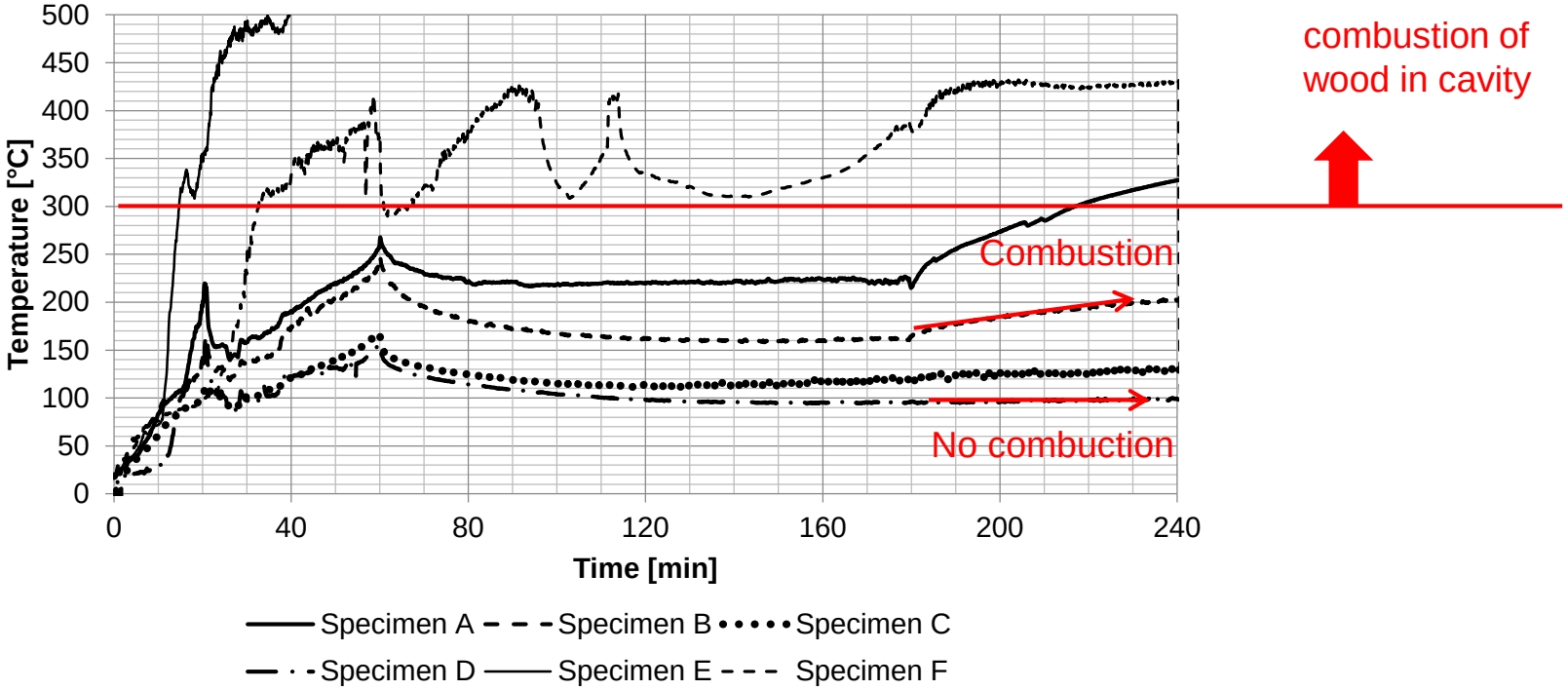
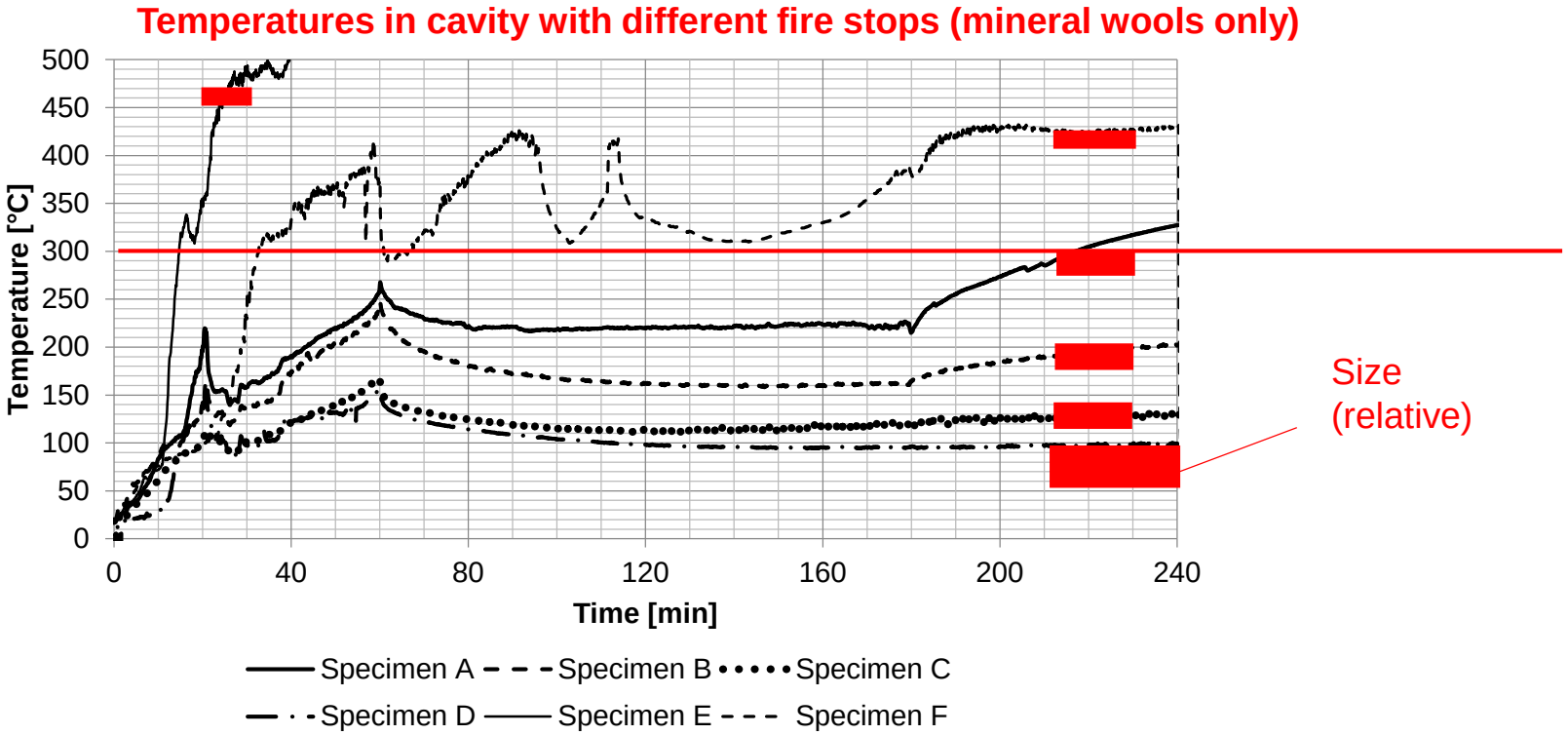
Appearance				
Unpressed density [kg/m³]	20	26	650	1310

Fire stops for combustible materials in cavities

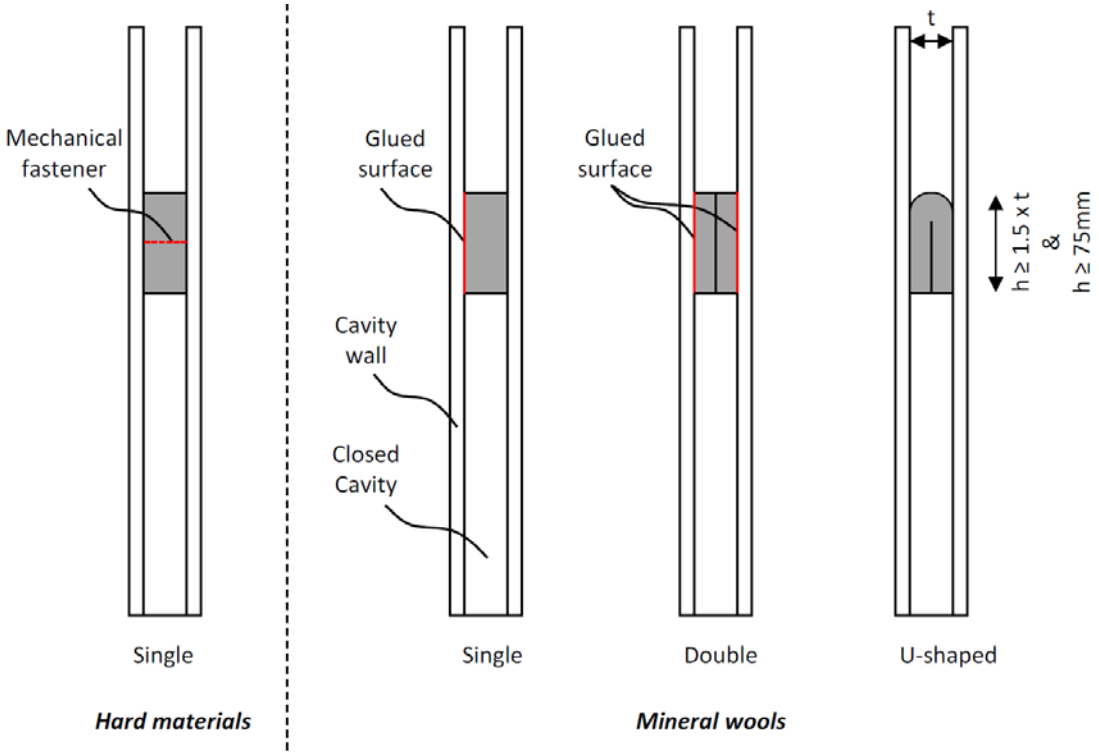
Temperatures in cavity with different fire stops (mineral wools only)



Fire stops for combustible materials in cavities



Guidelines



Guide lines for mineral wools:

Minimum size and density after installation:

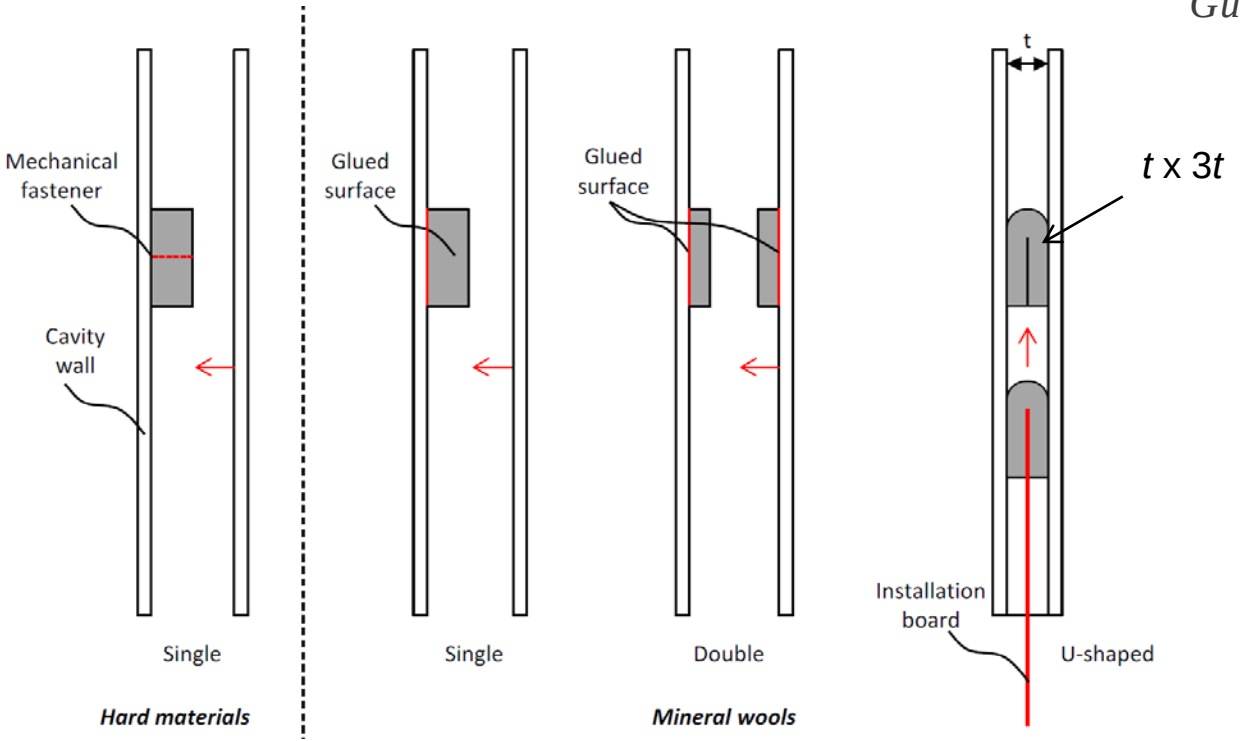
- *Minimum height after installation:*

$h>1.5t \quad \& \quad h>75mm$

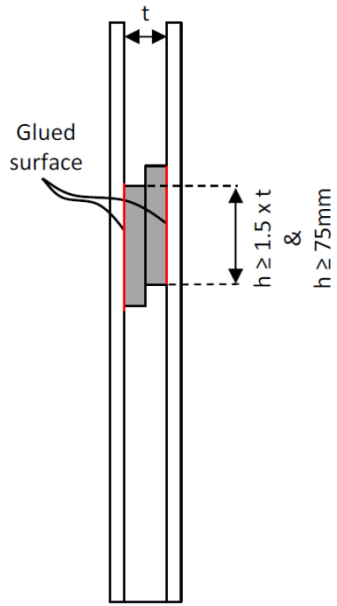
- *Minimum density after installation:*

$\rho=50\ kg/m^3$

Guidelines



Guidelines for mineral wools:



TEST SERIE 3

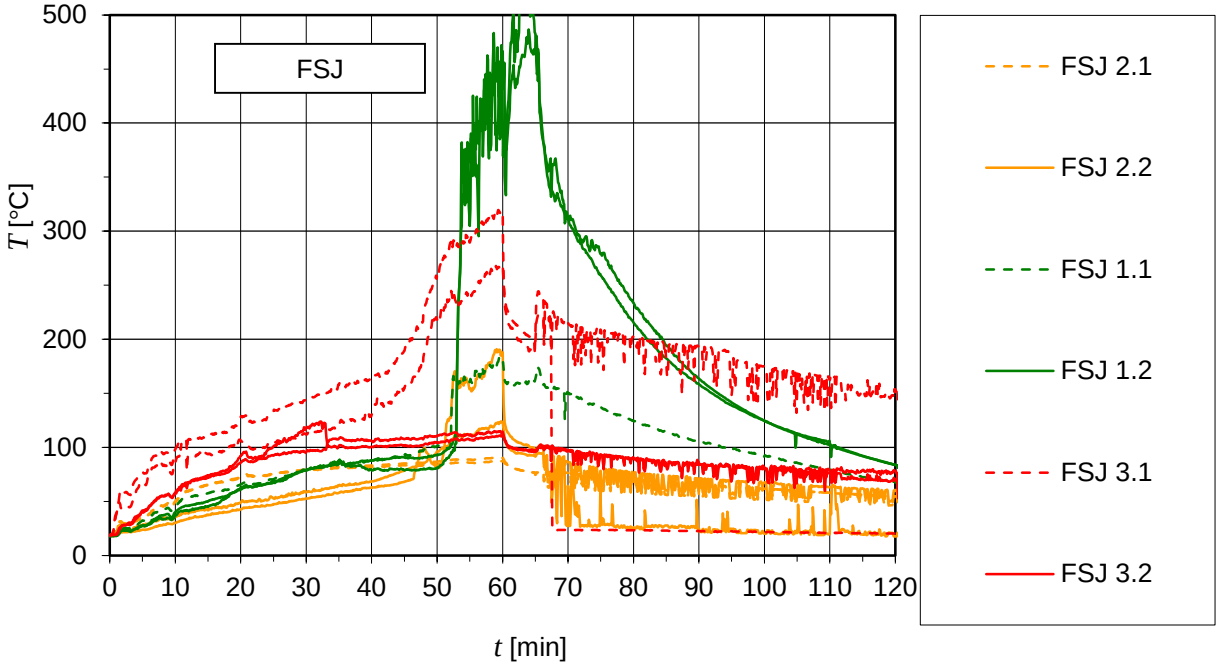
The influence of the following parameters:

- connection details between cavity barriers
- type of combustible material of the cavity wall
- the influence of plastic coating of the cavity barriers

Specimen	FSJ 1 to 3
Cavity barrier	glass wool with or without cover
Dimensions [mm]	50x160
Appearance	
Unpressed density [kg/m³]	26

Name of specimen	Overlapping joint	Butt joint
Plastic covered cavity barrier & particle board cavity wall material	*FSJ1.1**	*FSJ1.2**
Cavity barrier **without plastic covering** & particle board cavity wall material	*FSJ2.1*	*FSJ2.2*
Plastic covered cavity barrier & **plywood** cavity wall material	*FSJ3.1*	*FSJ3.2*

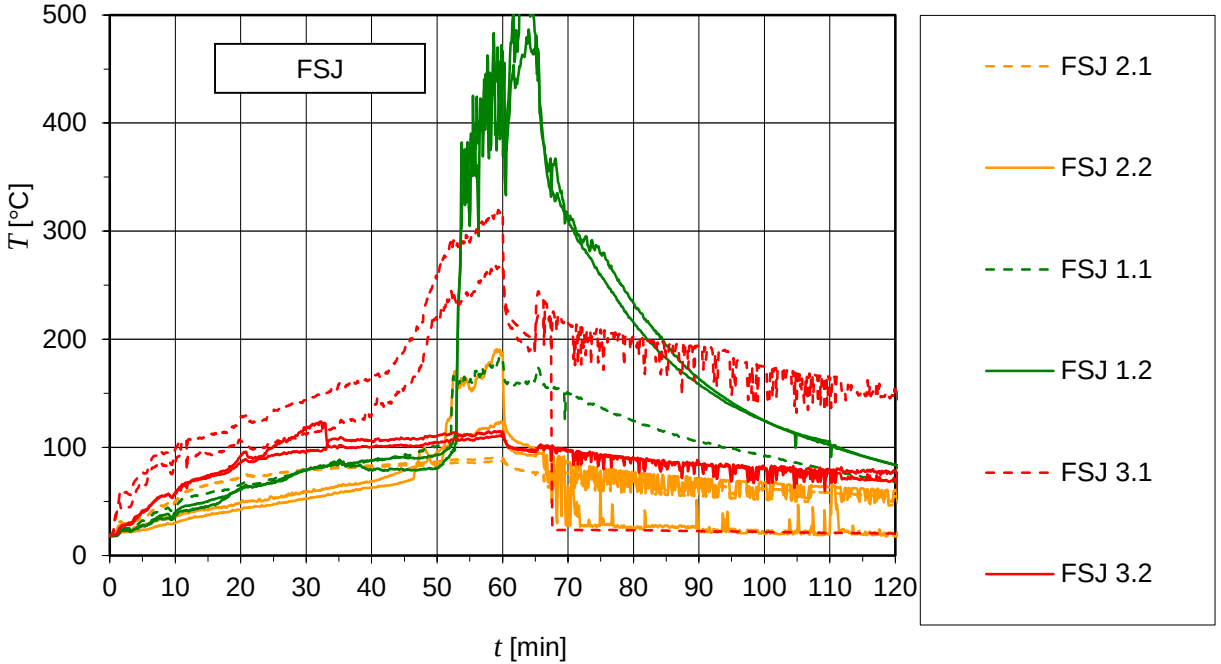
1 hour standard fire + 1 hour decay



Name of specimen	Overlapping joint	Butt joint
Plastic covered cavity barrier & particle board cavity wall material	*FSJ1.1**	*FSJ1.2**
Cavity barrier **without plastic covering** & particle board cavity wall material	*FSJ2.1*	*FSJ2.2*
Plastic covered cavity barrier & **plywood** cavity wall material	*FSJ3.1*	*FSJ3.2*

Test FSJ 1.2 showed the highest temperatures in the cavity after one of the cavity barriers fell into the furnace.

Best performance without plastic (FSJ2.1 and FSJ2.2).



Installation

Observations

FSJ1.1

FSJ1.2

FSJ2.1

FSJ2.2

FSJ3.1

FSJ3.2

Extinguishing – preliminary study

There was still combustion in the cavities of specimen FSJ1 and FSJ3.

Hole drilled through the cavity wall. Extinguished with CO2 or powder.

Consumed weight of substance for extinguishment

Specimen	Extinguishment with	
	CO2	Powder
FSJ1 (left)	62 g	
FSJ1 (right)	96 g	
FSJ3 (right)		1324 g
FSJ3 (left)	157 g	724 g

Powder - successful with large amount (9.5 kg/m^2).

CO2 - required 440 to 1100 g/m^2.

(minimum amount that could be injected with one shot of the extinguisher).

Conclusions

Based on the review of real cavity fires, the method to assess cavity barriers was proposed.

The method includes:

- a period after a fully developed fire,
- combustible materials within the cavity
- potential heating of the air within a cavity.

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Conclusions

- The temperatures can rise significantly during the test in the enclosed cavities.
- The use of compressible (soft) insulation material which is installed firmly in the cavity, will limit the air flow.
- Cavity barriers with a compressed density of 50 kg/m^3 for glass wool can successfully prevent a cavity fire
- Cavity barriers should be kept in place, by for example gluing or, by robust designing.
- More air and smoke travels past cavity barriers with plastic covering, as the wrinkles in the plastic material formed channels for the air to flow through.
- More tests are needed to confirm whether this rule is generally applicable for different insulation materials.

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Conclusions

- Air channels through connections of cavity barriers can be significant and should be avoided
- An overlapping joint between two parallel cavity barriers can potentially involve undesired air channels, which stimulate the temperature development in the cavity.
- Extinguishing strategies have to be developed

- Similar research is needed for the ventilated cavity barriers

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TACK!

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