REPORT

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SBUF

Model scale tests with fire stops

(1 appendix)

General

This report describes outcome and results of the the model scale tests with different cavity barriers.

Model scale tests were made on 2014 and 2015 in the model furnace at SP Wood Building Technology in Stockholm.

1 Introduction

This report covers the fire testing performed within the SBUF project 12993 “Fire stops in building constructions”.

2 Products

2.1 Cavity barriers

Tested cavity barriers consisted mainly of mineral wool products with and without plastic covering.

There were stone wool, HTE (high temperature extruded) mineral wool and traditional glass wool used in the specimens.

Two intumescent cavity barriers for the ventilated cavities were used in test specimen FS 8. There was a product with plastic cover and the product with steelnet.

Cavity barriers used in the tests are listed in Table 1

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Table 1. Cavity barriers

Test	Number of cavity barrier	Cavity barrier	Plasticized	Dimensions [mm]	Cavity length [mm]	U-shape, Double placing
1	FS1	HTE tätfiber	P	15x120	1000	U
	FS2	Stone wool		25x65	1000	
2	FS3	Glass wool	P	50x160	1000	U
	FS4	HTE tätfiber	P	35x95	1000	D
3	FS5.1	HTE Tätfiber	P	30x95	430	U
	FS5.2	HTE Drev		30x95	430	U
	FS6.1	HTE Tätfiber	P	35x95	430	U
	FS6.2	Glass wool	P	50x160	430	U
4	FS7.1	Glass wool	P	20x60	430	U
	FS7.2	Glass wool		20x100	430	U
	FS8.1	Intumescent			430	
	FS8.2	Intumescent with steelnet			430	

2.2 Boards, fasteners and additional material

For the test specimens the following materials were used

- Timber frame 50x50 or 50x30 mm^2
- Stone wool 133 kg/mm^3
- Gypsum plasterboards, Type F with thickness of 15 mm on the outer side
- Wooden particle boards with thickness of 11 mm on the cavity surfaces.

Self-drilling screws with lengths 41 mm and a nominal diameter of 3,0 mm were used to fasten boards to the timber frame.

To keep the specimens as air-tight as possible an aluminium tape was attached in the joints at the exposed side and non-exposed side as well as on the sides of the specimens.

For temperature measurements thermocouples type K were used. Crimped junctions with a contact length of about 3 mm were used.

3 Fire tests

3.1 General

Fire tests were conducted at model scale furnace of SP Wood Building Technology.

All specimens were built at SP Wood Building Technology and conditioned in a controlled climate chamber at 20 °C and 65% RH before the fire tests.

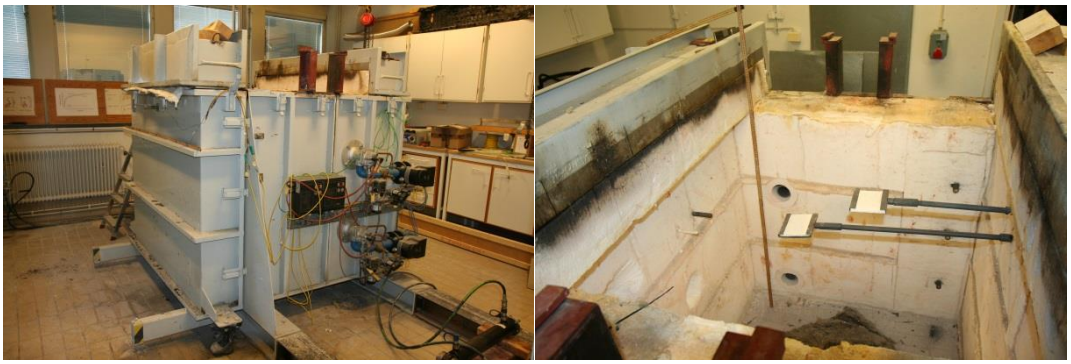


Figure 1. Model scale furnace

Figure 2. Test assembly

All the furnace data for different tests see Annex A.

3.2 Test serie 1

The test rig consists of two equal self-supporting test assemblies. Each test assembly had one cavity. This rig was placed on top of the horizontal furnace. All discontinuities were sealed with soft stone wool. The rest of the furnace top was closed by steel lockers.

The test assembly consisted of two timber studs (500 x 50 x 30 mm) providing a distance for cavity. These studs were protected by stone wool (density 133 kg/m^3) from cavity side. This frame was covered by gypsum plasterboards (type F with thickness 15 mm) and wooden board on the cavity side.

Specimens for tests FS1 to FS4 were constructed with cavity width of 30 mm and cavity length 1000 mm. Cavities had wooden surfaces.

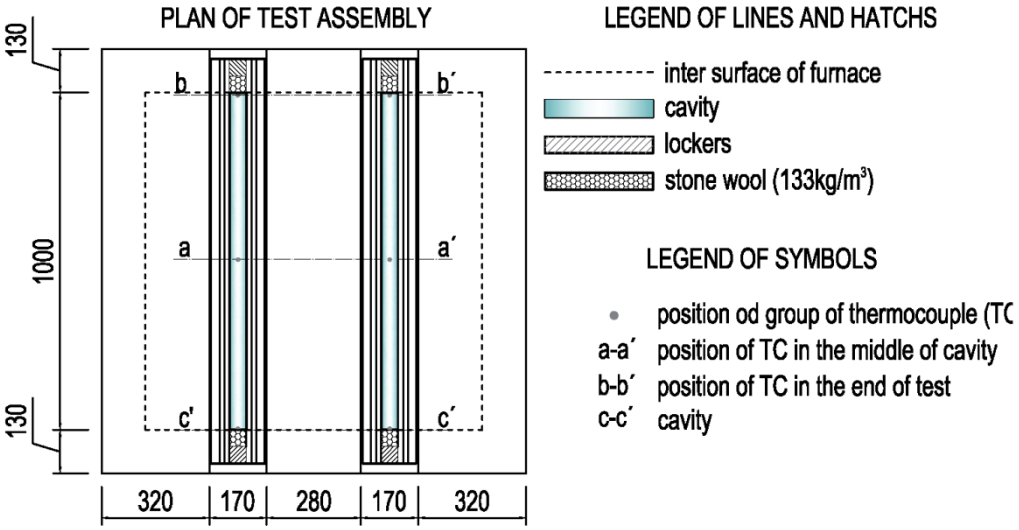


Figure 3. Plan of test assembly forspecimens FS1 to FS4

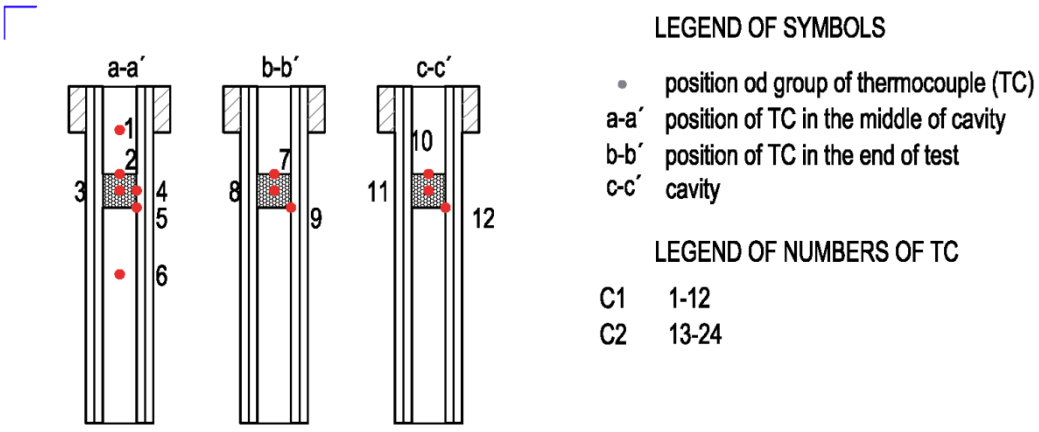


Figure 4. Section of test assembly forspecimens FS1 to FS4

3.2.1 Tests FS1 and FS2

Building of the specimen FS1, FS2 is shown on the photos on Table 2. Pictures during and after test see Table 3. Temperature measurements see Figure 5 and Figure 6.

Table 2. Building of specimen FS1 and FS2.

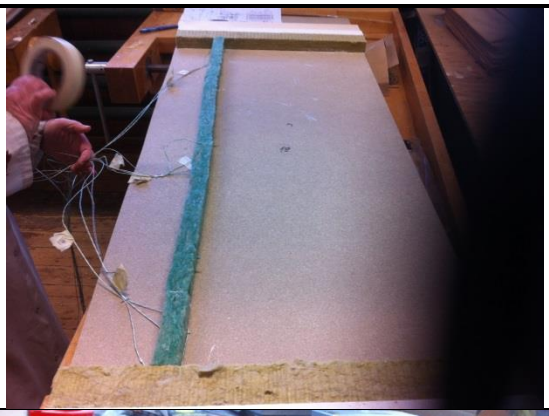
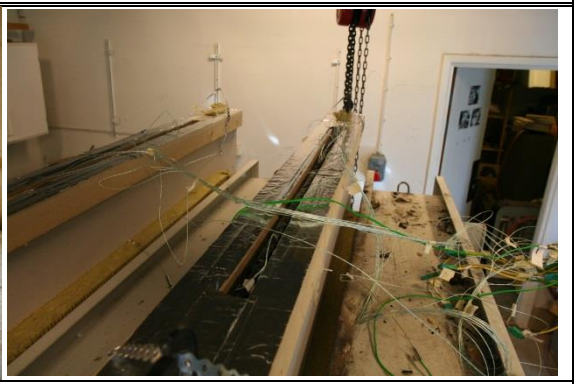
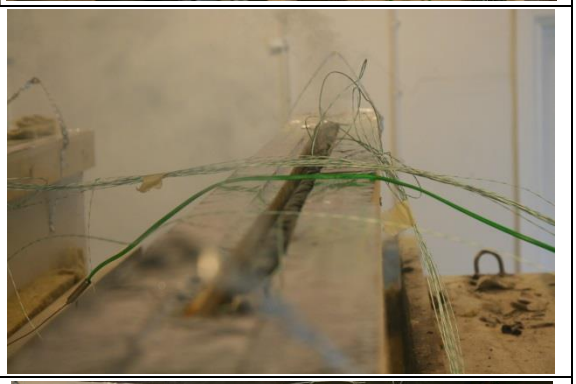
FS1	FS2
	
	

Table 3. Photos during and after fire test of specimen FS1 and FS2.

Fire test FS1, FS2	
	
	
	
	

Test results FS1, FS2

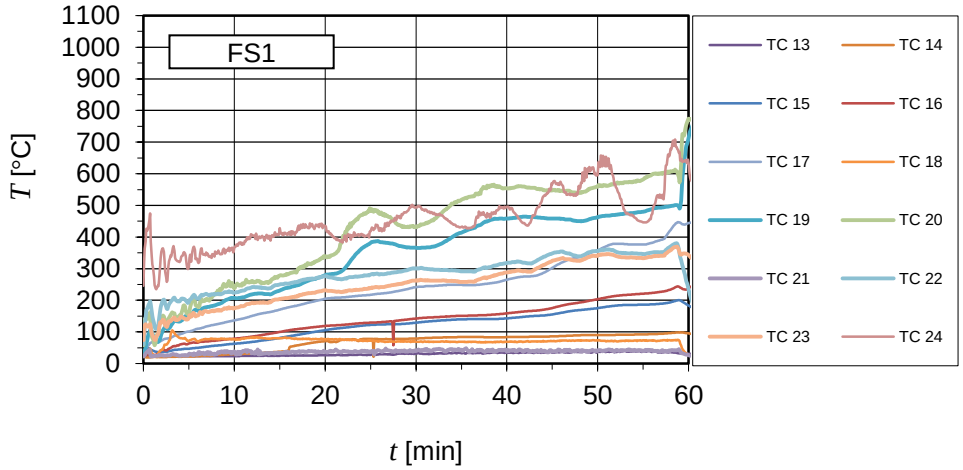


Figure 5. Temperature recording on specimen FS1.

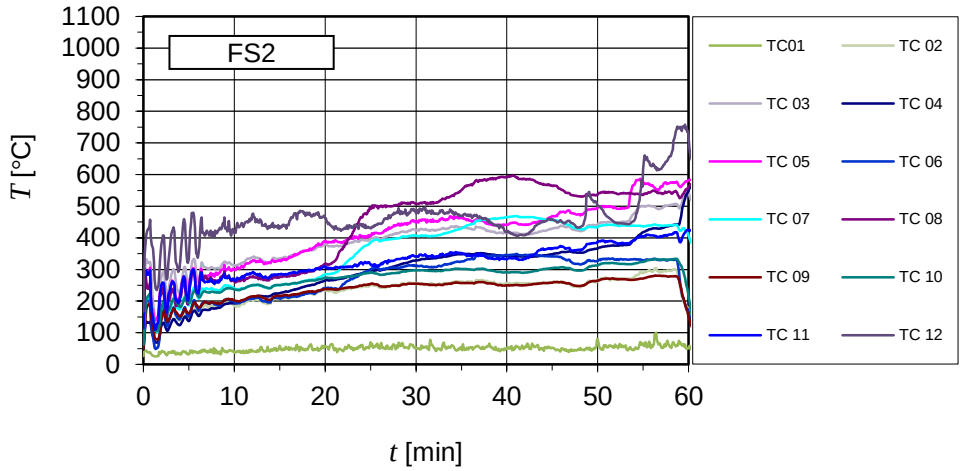


Figure 6. Temperature recording on specimen FS2.

3.2.2 Tests FS3 and FS4

Building of the specimen FS3, FS4 is shown on the photos on Table 4. Pictures during and after test see Table 5. Temperature measurements see Figure 7 and Figure 8.

Table 4. Building of specimen FS3 and FS4.

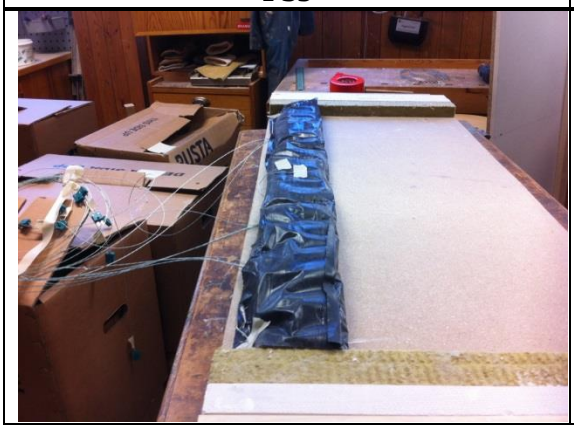
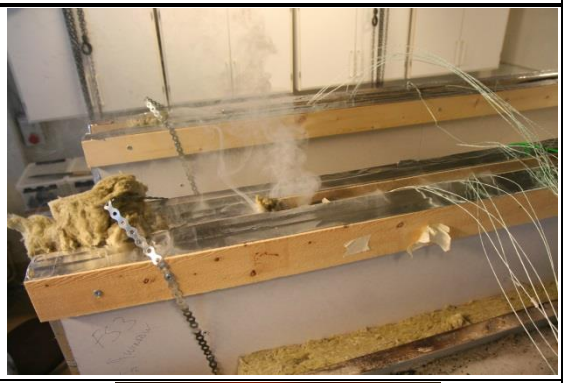
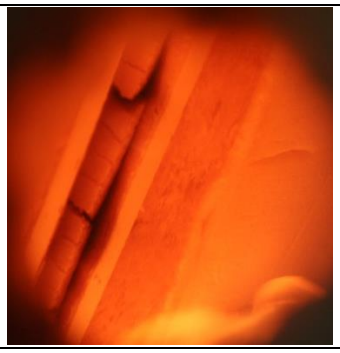
FS3	FS4
	

Table 5. Photos during and after fire test of specimen FS3 and FS4.

Fire test FS3, FS4	
	
	

Test results FS3, FS4

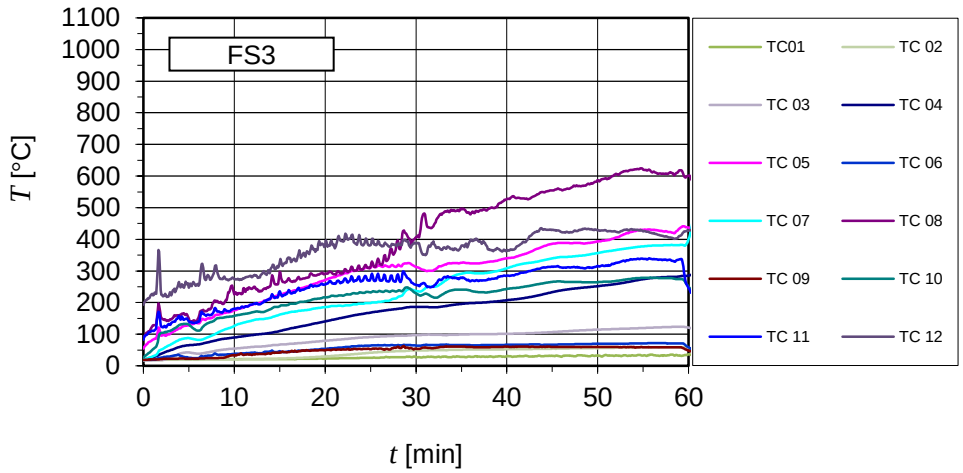


Figure 7. Temperature recording on specimen FS3.

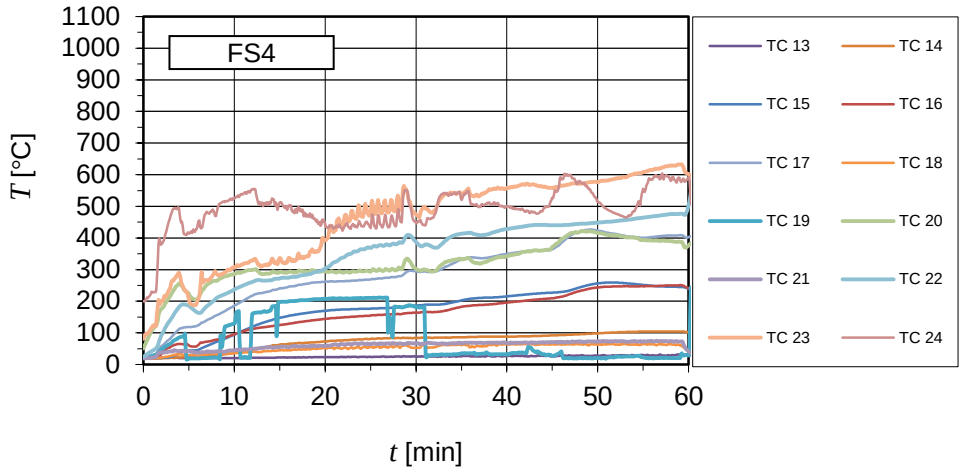


Figure 8. Temperature recording on specimen FS4.

3.3 Test serie 2

The test rig consists of two equal self-supporting test assemblies. Each test assembly had two cavities. The rig was placed on top of the horizontal furnace. All discontinuities were sealed with stone wool. The rest of the furnace top was closed by steel lockers.

The test assembly consisted of three timber studs (500 x 50 x 50 mm) providing a distance for cavity. These studs were protected by stone wool (density 133 kg/m^3) from cavity side. This frame was covered by gypsum plasterboards (type F with thickness 15 mm) and wooden board on the cavity side.

Specimens for tests FS5 to FS8 were constructed with cavity width of 50 mm and cavity length 430 mm. Cavities had wooden surfaces.

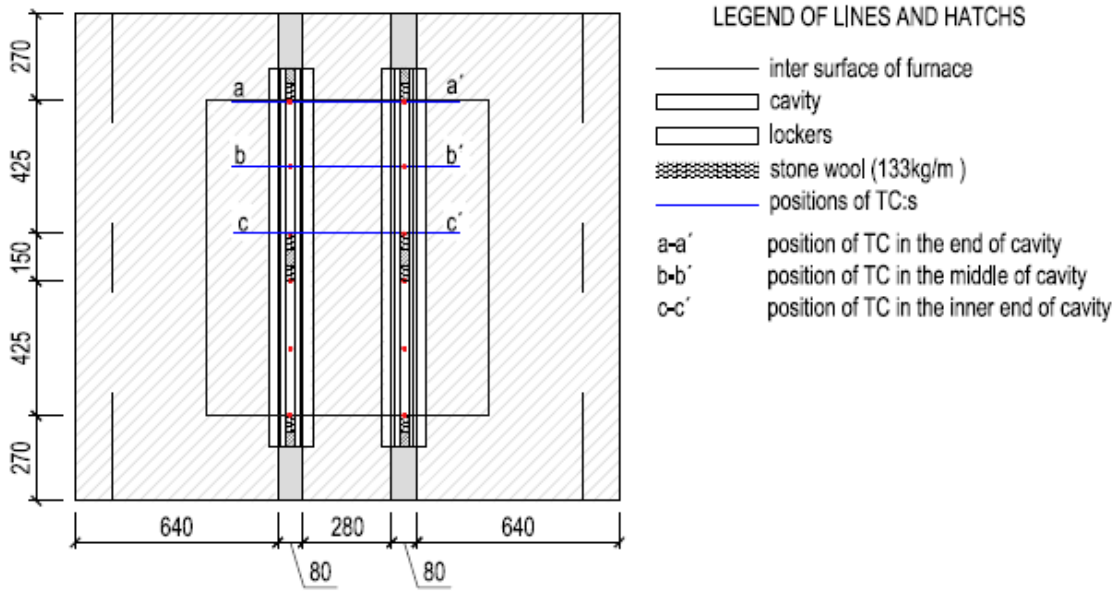


Figure 9. Plan of test assembly for specimens FS5 to FS8

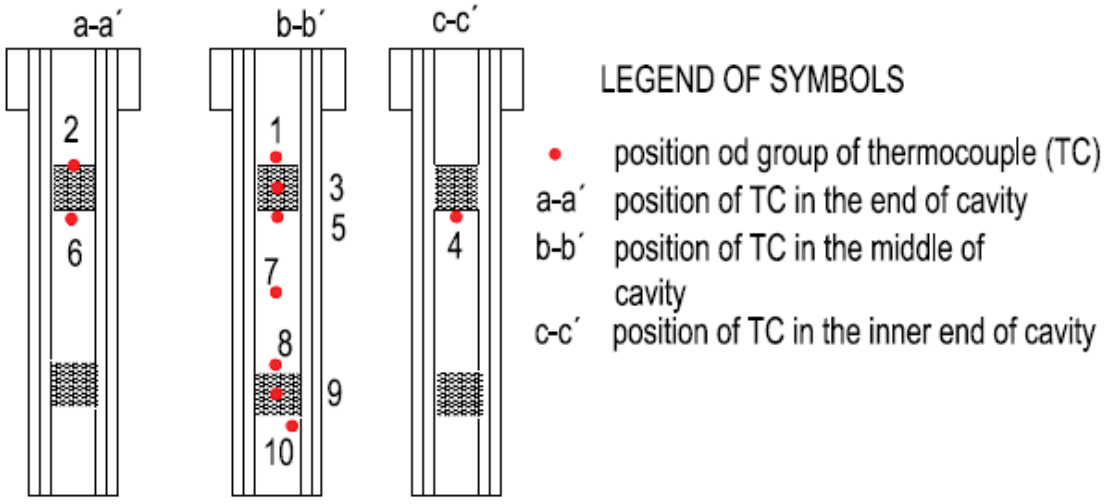


Figure 10. Section of test assembly for specimens FS5 to FS8

3.3.1 Tests FS5

Building of the specimen FS5 is shown on the photos on Table 6. Pictures during and after test see Table 8. Temperature measurements see Figure 11 to Figure 14.

Table 6. Building of specimen FS5.








Test results FS5

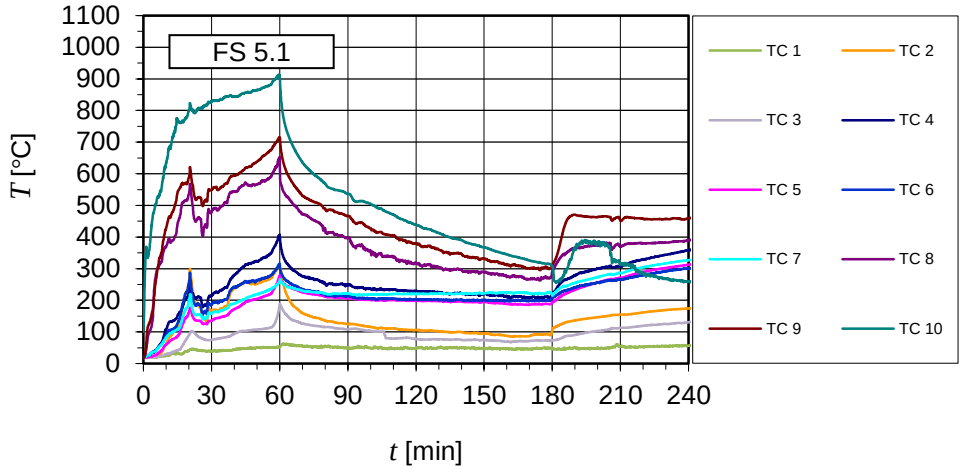


Figure 11. Temperature recording on specimen FS5.1 including post fire behaviour.

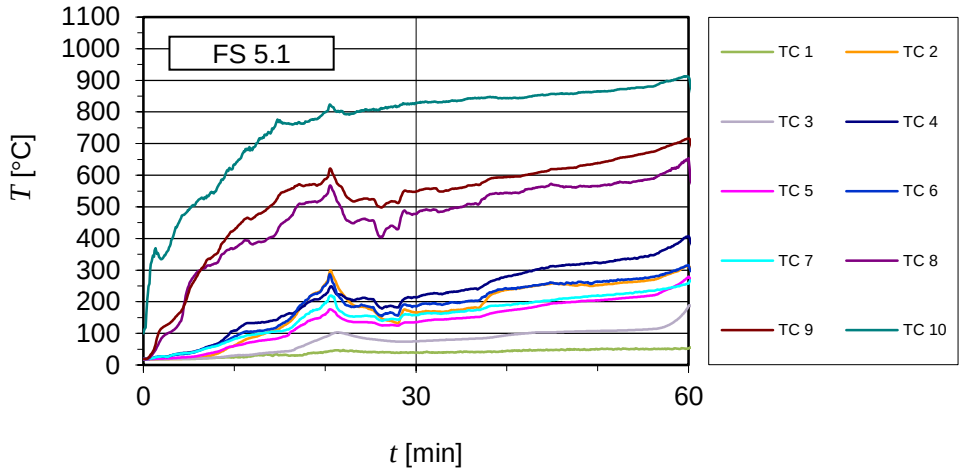


Figure 12. Temperature recording on specimen FS6.2 during 60 min fire.

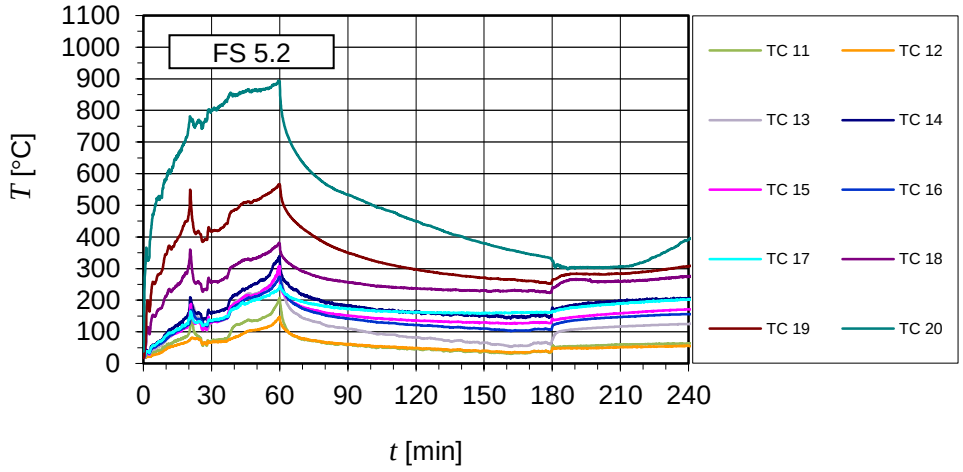


Figure 13. Temperature recording on specimen FS5.2 including post fire behaviour.

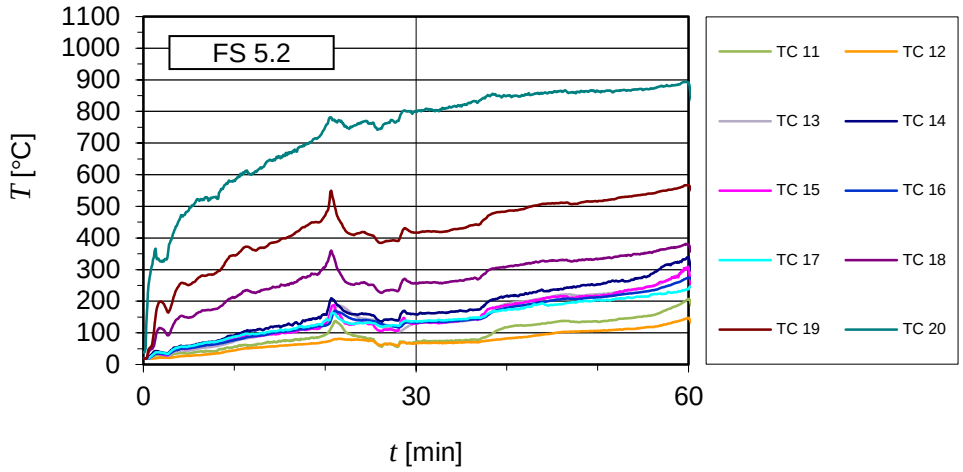


Figure 14. Temperature recording on specimen FS5.2 during 60 min fire.

3.3.2 Tests FS6

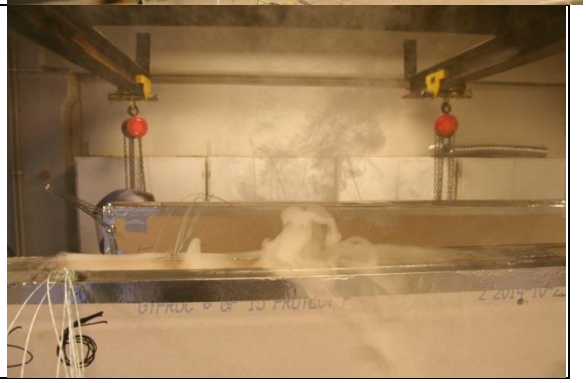
Building of the specimen FS6 is shown on the photos onTable 7. Pictures during and after test see Table 8. Temperature measurements see Figure 15 to Figure 18.

Table 7. Building of specimen FS6.


Table 8. Photos during and after fire test of specimen FS5 and FS6.





Test results FS6

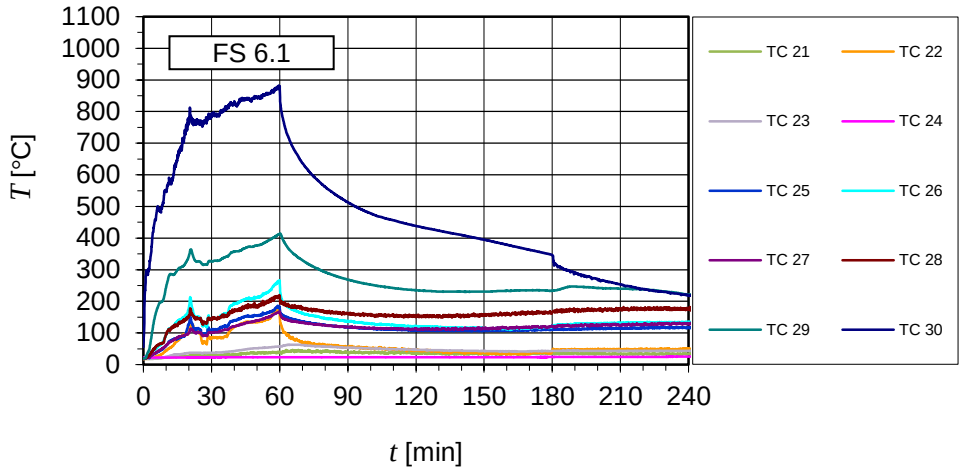


Figure 15. Temperature recording on specimen FS6.1 including post fire behaviour.

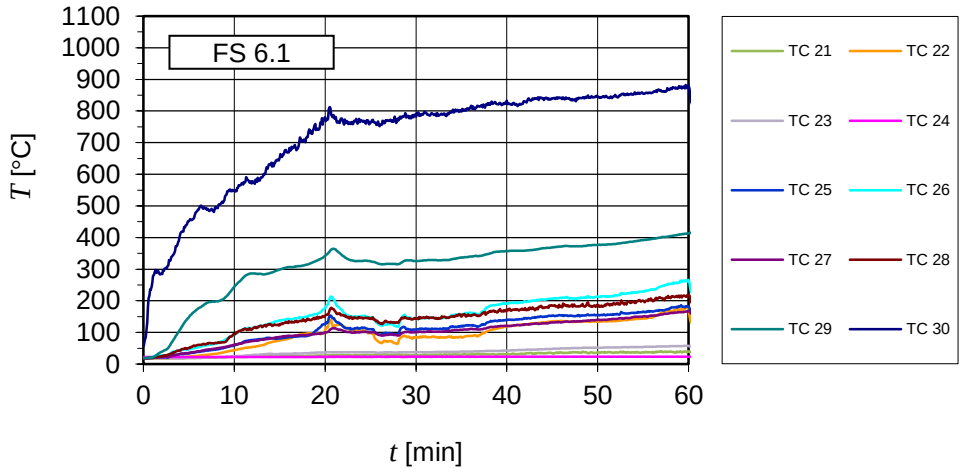


Figure 16. Temperature recording on specimen FS6.2 during 60 min fire.

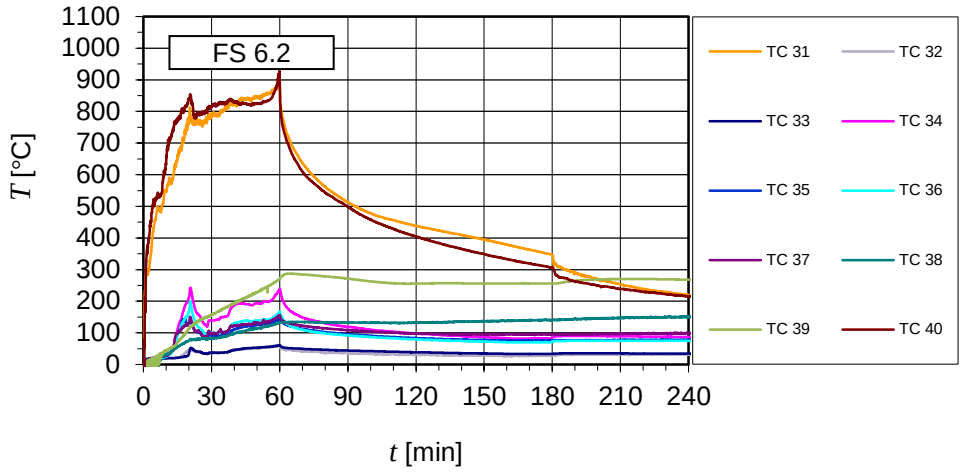


Figure 17. Temperature recording on specimen FS6.2 including post fire behaviour.

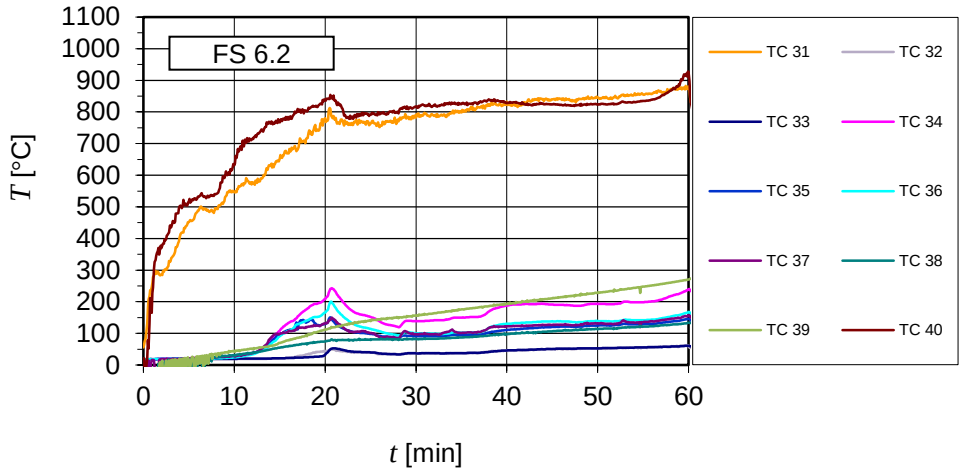


Figure 18. Temperature recording on specimen FS6.2 during 60 min fire.

3.3.3 Tests FS7

Building of the specimen FS7 is shown on the photos on Table 9. Pictures during and after test see *Table 11*. Temperature measurements see Figure 19 to Figure 22.

Table 9. Building of specimen FS7.

Test results FS7

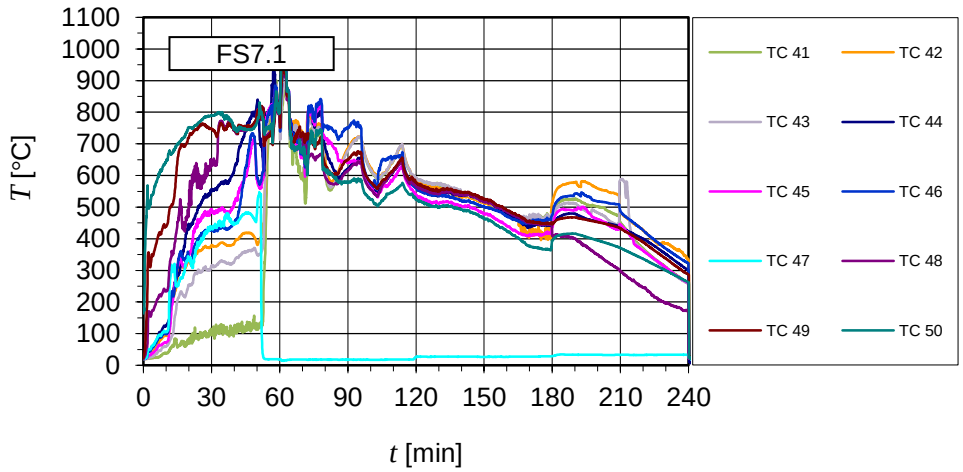


Figure 19. Temperature recording on specimen FS7.1 including post fire behaviour.

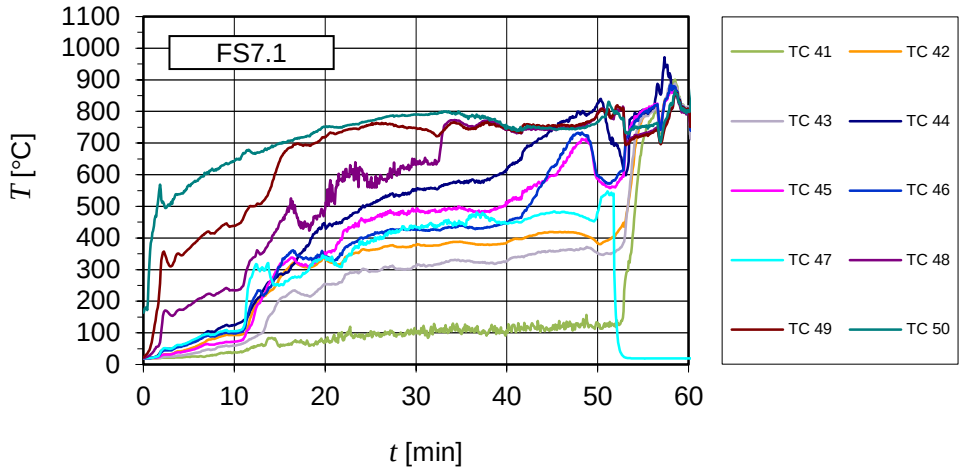


Figure 20. Temperature recording on specimen FS7.1 during 60 min fire.

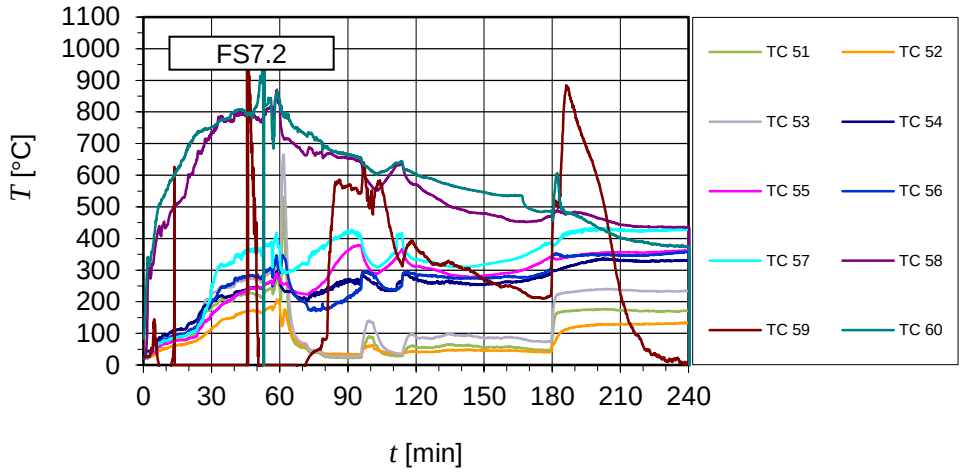


Figure 21. Temperature recording on specimen FS7.2 including post fire behaviour.

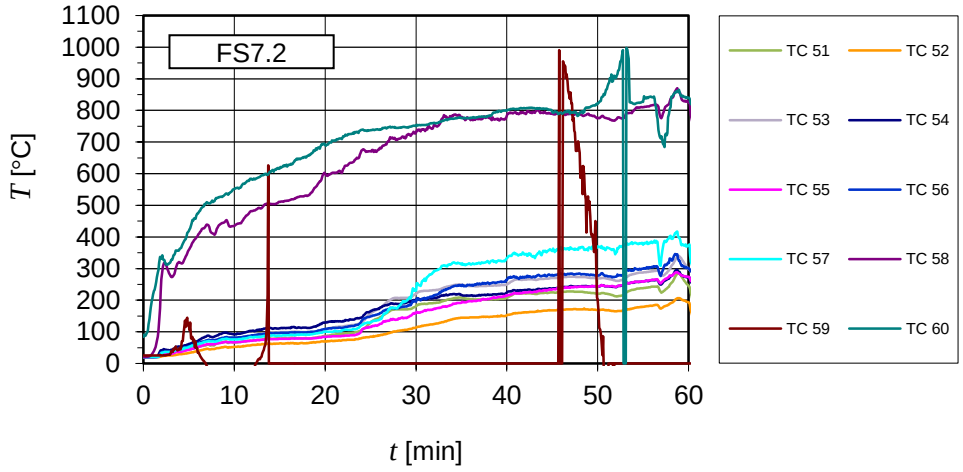


Figure 22. Temperature recording on specimen FS7.2 during 60 min fire.

3.3.4 Tests FS8

Building of the specimen FS8 is shown on the photos on Table 10. Pictures during and after test see Table 11. Temperature measurements see Figure 23 to Figure 26.

Table 10. Building of specimen FS8.

Table 11. Photos during and after fire test of specimen FS75 and FS8.

Test results FS8.1, FS8.2

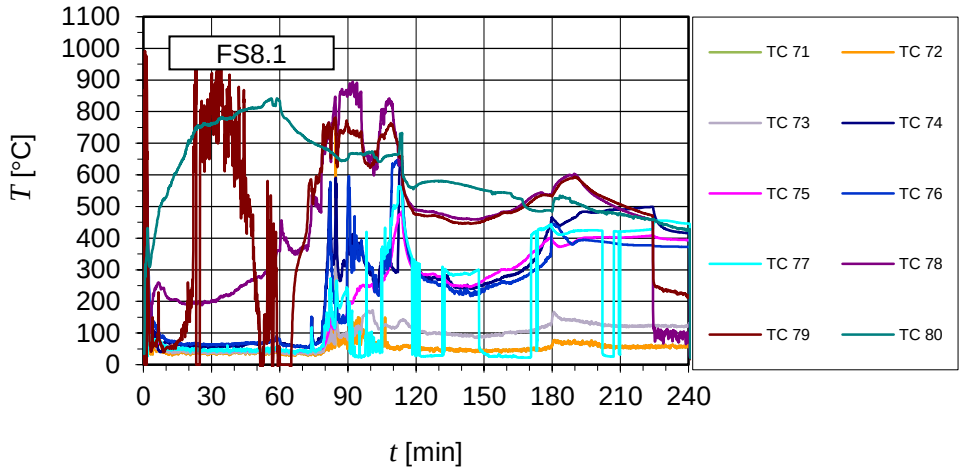


Figure 23. Temperature recording on specimen FS8.1 including post fire behaviour.

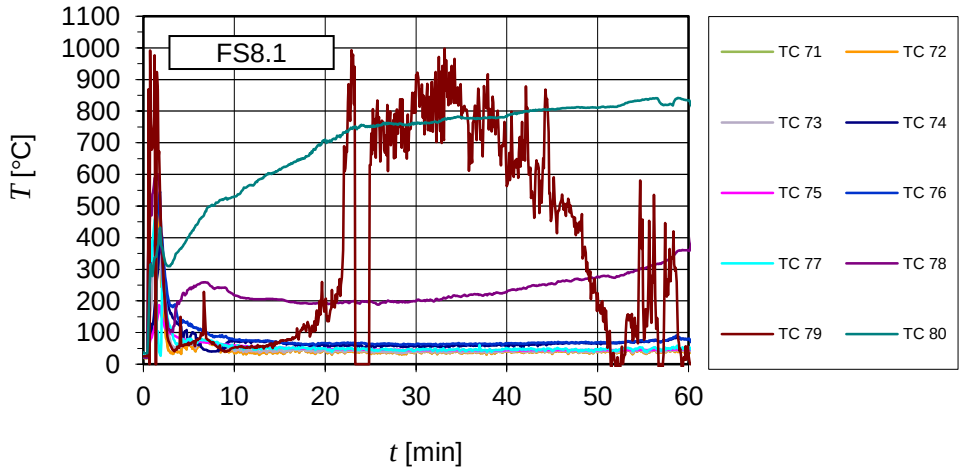


Figure 24. Temperature recording on specimen FS8.1 during 60 min fire.

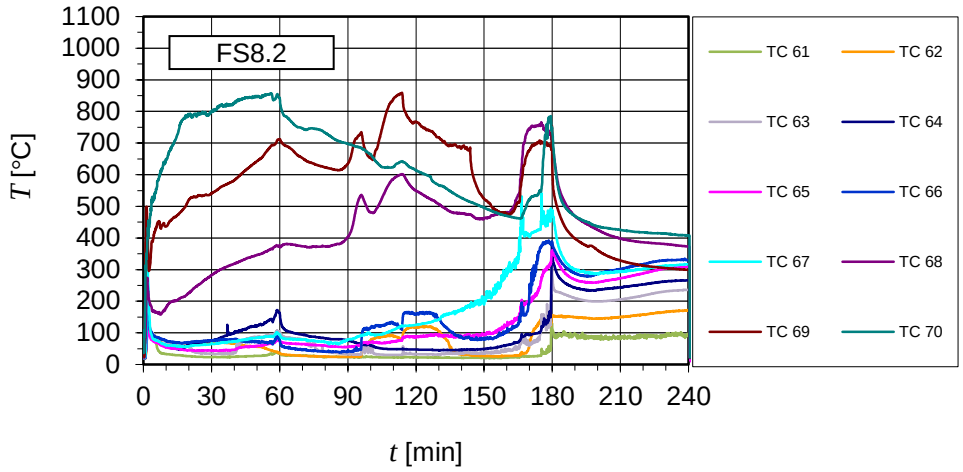


Figure 25. Temperature recording on specimen FS8.2 including post fire behaviour.

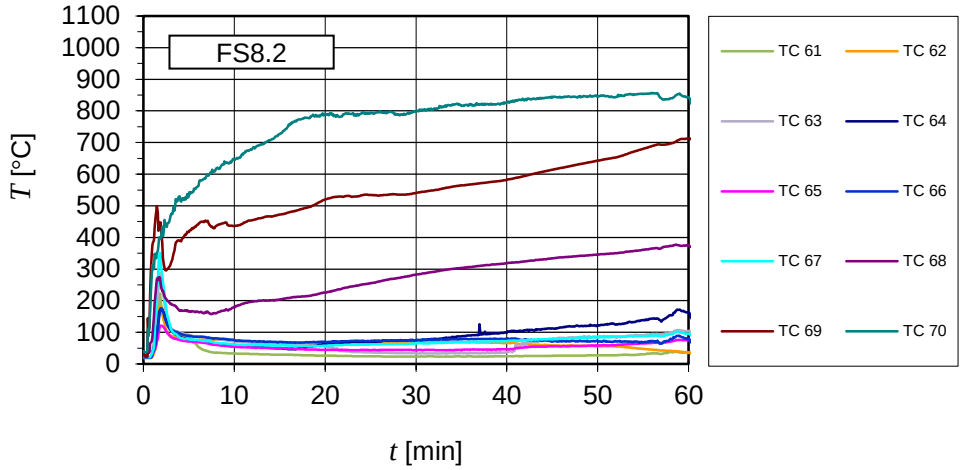


Figure 26. Temperature recording on specimen FS8.2 during 60 min fire.

4 Analysis and discussions

Following analyse includes the comparison of different fire stops based on previously described test results.

Comparison of temperatures in the middle of the cavity

Figure 27 shows the measured temperatures in the middle of the cavity, comparative for all the non-ventilated cavity barriers. Cavity with barriers of glass wool, dimensions 20x60 m^2 and wrapped in plastic, resulted in much higher temperature than the rest of the specimens. The reason to the abrupt decrease in temperature (from 550 to 50 °C) for FS7.1 may due to defection of the thermocouple when stone wool was placed in the cavity.

FS6.1 and FS6.2 shows the lowest measured temperatures in the cavity and the curves follow approximately each other during the whole test.

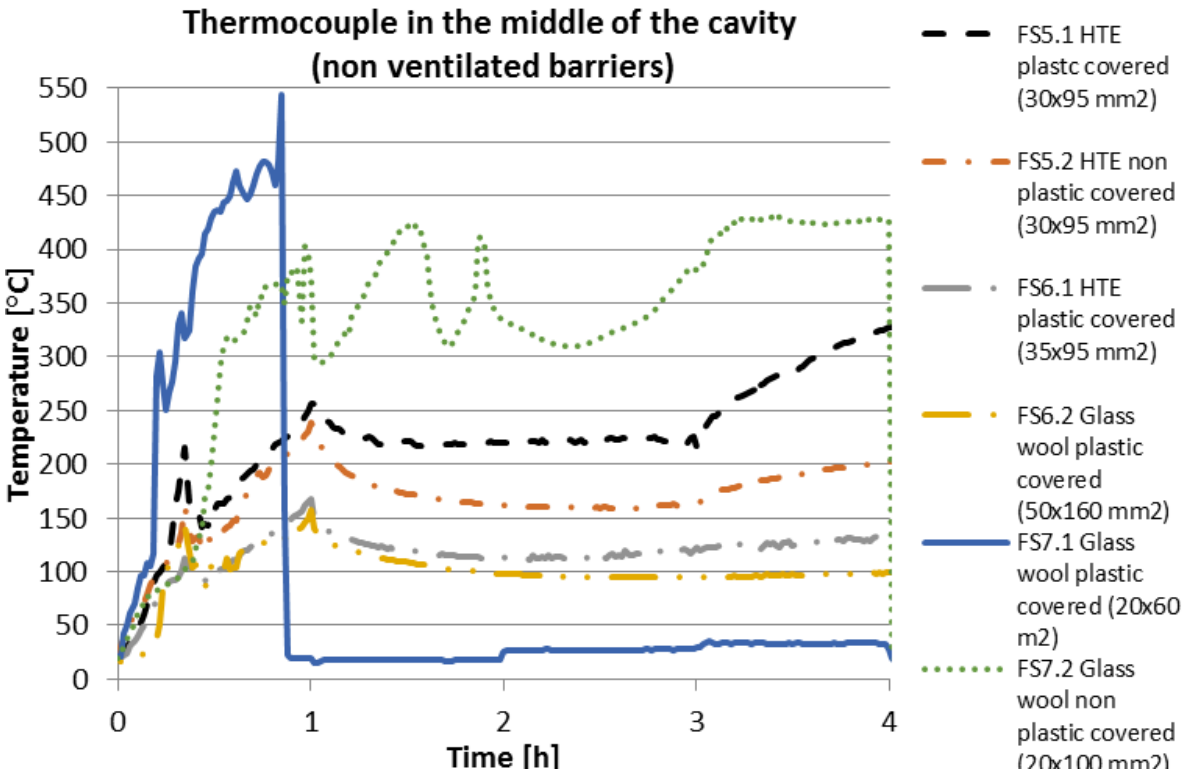


Figure 27. Temperatures in the middle of the cavities, position TC7.

For the ventilated cavity barriers, the measured temperatures in the middle of the cavity are presented in Figure 28. The temperature from the cavity with the intumescent mass with steel net, as barriers, shows a curve that fluctuates. Temperature increases and decreases back and forth during the whole test. One similarity is that the temperature increases directly in the beginning of the test.

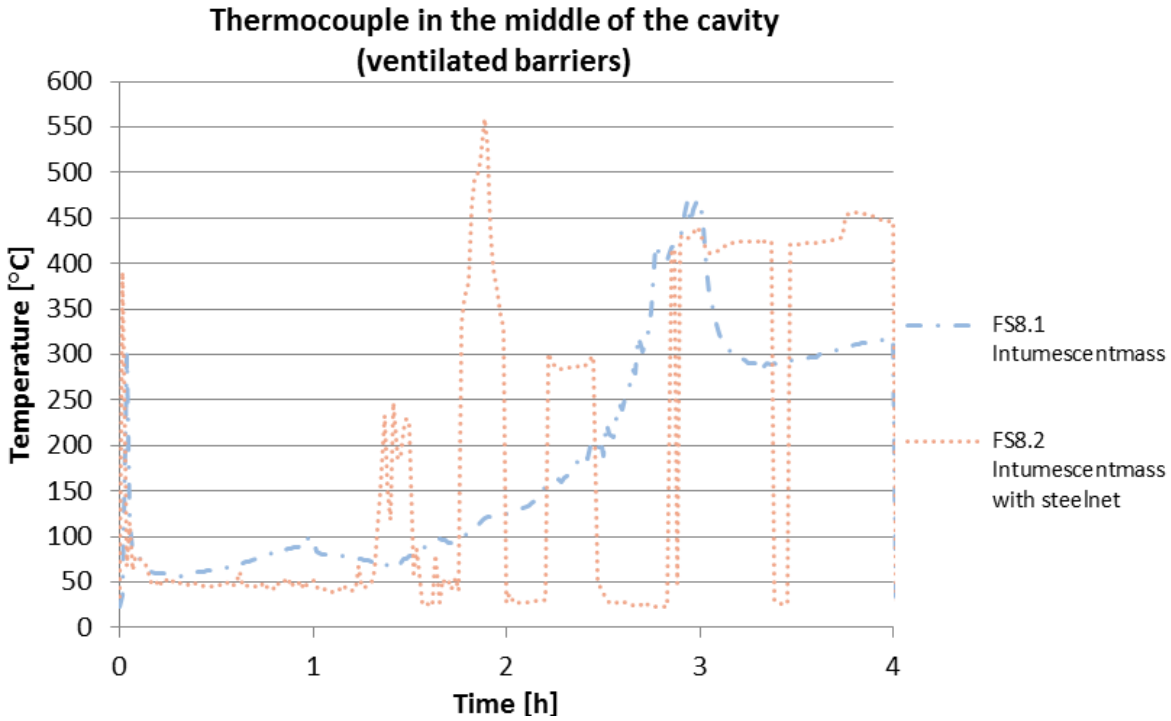


Figure 28. Comparison between measured temperatures in the middle of the cavity, at position TC7, for the cavity with intumescent mass and the one with intumescent mass with steel net.

HTE mineral wool with and without plastic cover

Comparison of temperature measurements for cavity barriers FS5.1 and FS5.2 is shown on Figure 29. The barriers are made of the same mineral wool. Difference between the materials of the barriers is the plastic cover; the material HTE has a plastic cover.

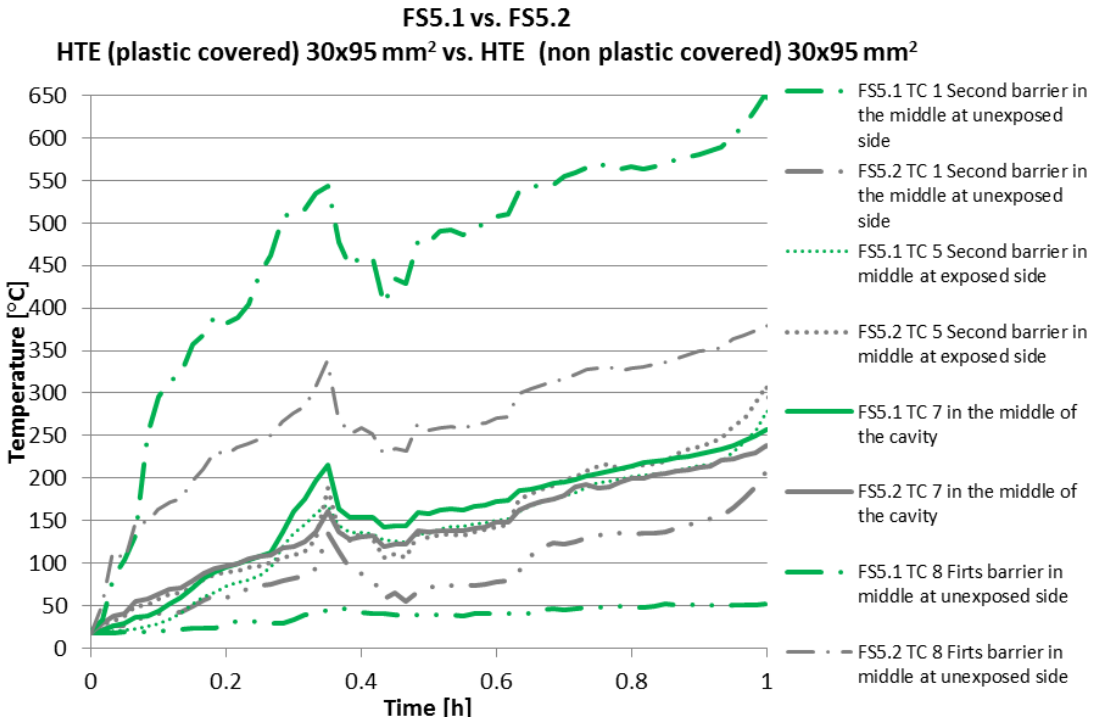


Figure 29. Comparison between FS5.1 and FS5.2 with the plastic cover as varying factor.

First cavity barrier of HTE mineral wool with plastic cover, resulted in higher temperatures on the unexposed side compared to the first cavity barrier of the same material without plastic cover.

Figure 30 presents the measured temperatures at the middle of the barrier at the unexposed side. The differences between the temperatures are 350 - 400 °C.

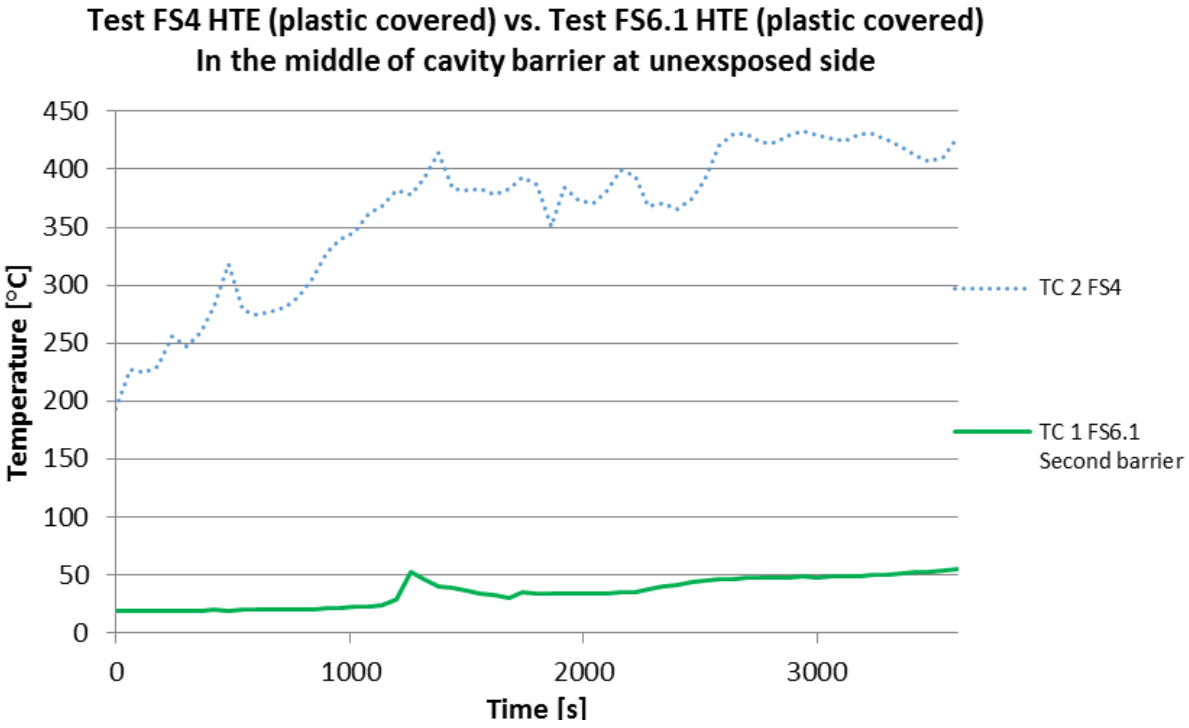


Figure 30. Comparison between cavity FS4 and FS6.1 at TC1.

In the middle of the cavity barriers the measured temperatures are shown in Figure 31. The temperatures from FS4 and FS6.1 follow each other during the first 15 minutes and then the temperature in FS6.1 peak 30 degrees. Furthermore, the temperature in FS3, middle if the barrier, is approximately the same during the whole test. The temperature differs with 10 °C from the start to the end of the test for FS4.

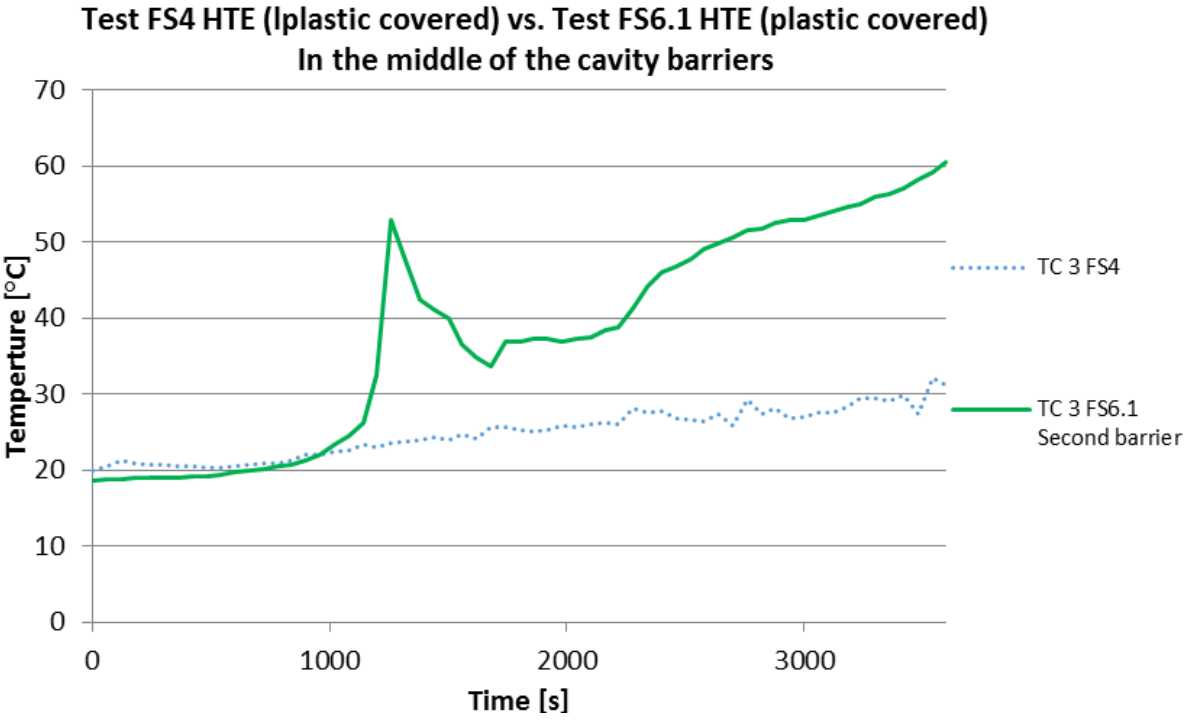


Figure 31. Comparison between cavity FS4 and FS6.1 at TC3.

Glass wool cavity barriers

Figure 32 presents the difference between the cavity barriers FS6.2 and FS7.1. Cavity barriers are made of glass wool with different cross section area. Cavity barriers are placed as U-shape. The barrier FS6.2 with cross section area of 50 x 160 mm^2 closes the cavity more efficient than the barrier with the cross section area of 20 x 50 mm^2.

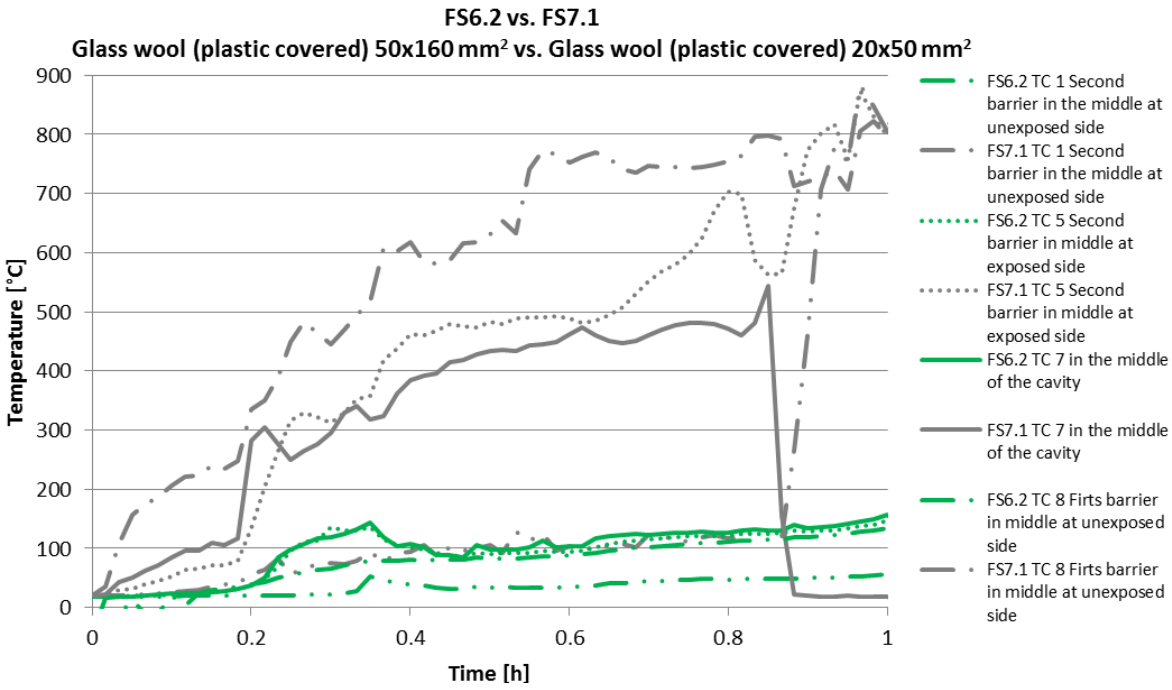


Figure 32. Comparison between FS6.2 and FS7.1 with the cross section area as varying parameter.

The sudden decrease of the measured temperature at position TC7 after approximately 50 minutes may due to a defection of the thermocouple. The temperature decrease of FS7.1 after 0,8 h is caused by closing the cavity with stone wool because of failure of the cavity barriers.

In Figure 33 the measured temperatures for the unexposed side on the middle of the barriers are presented. The temperature from FS3 follows the temperature for the second barrier more than the temperature from the first barrier in test FS6.2. The positions at the second barrier in FS6.2 show a lower temperature comparison to the temperature in FS3 due to the protective effect of the first barrier.

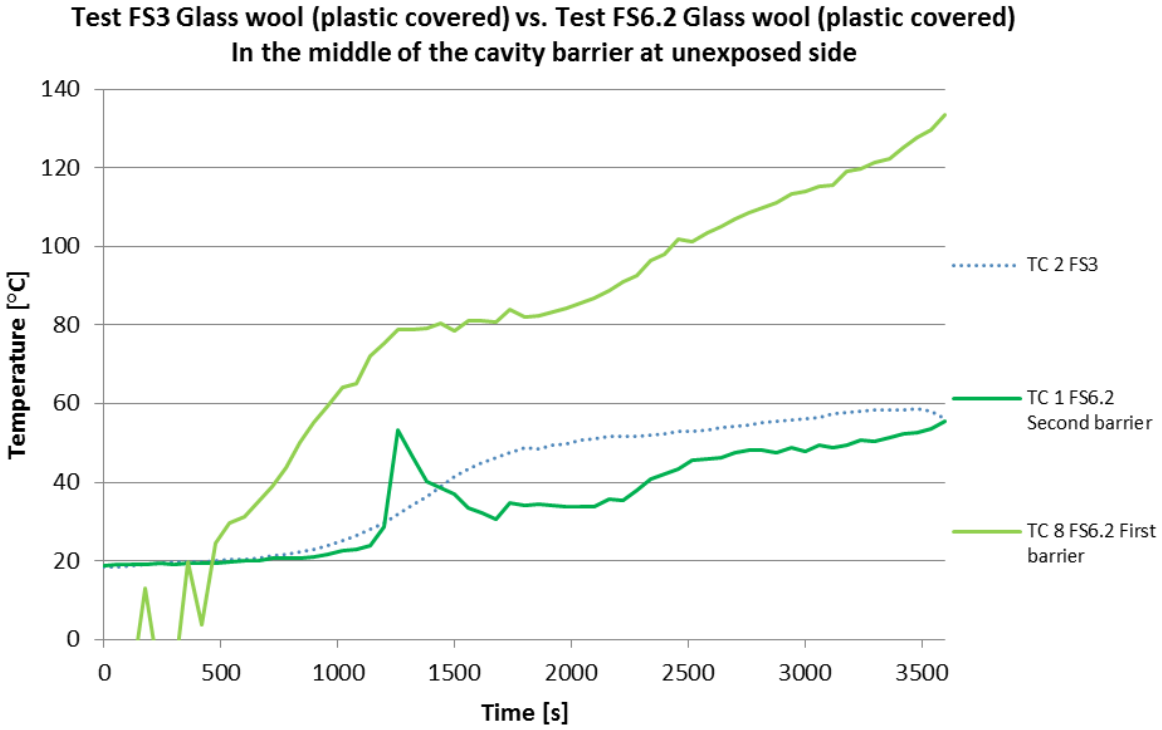


Figure 33. Comparison between cavity FS3 and FS6.2 at TC1 and TC8.

The measured temperatures in the middle of the cavity are presented in Figure 34. The temperature between two barriers shows a higher value than the test with one barrier.

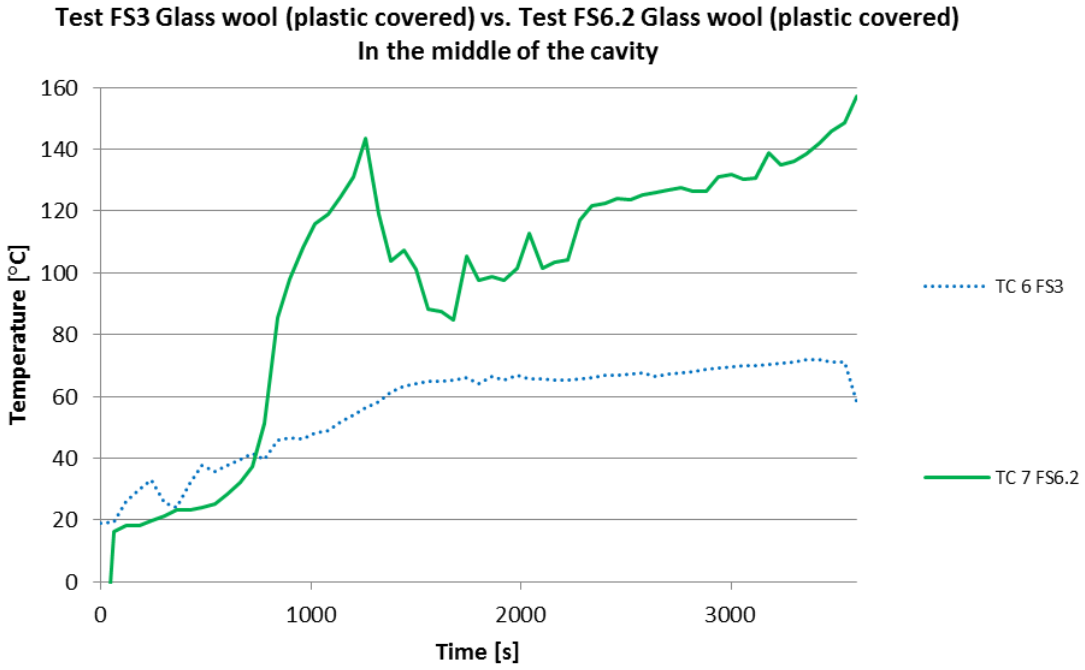


Figure 34.Comparison between cavity FS3 and FS6.2 at TC7.

Intumescent cavity barriers

Figure 35 shows the comparison between two intumescent cavity barriers. The intumescent mass result in a lower temperature during the test compared to the intumescent mass with steel net. The temperature in FS8.1 shows more legible curves, they vary not as much as the intumescent mass with steel net.

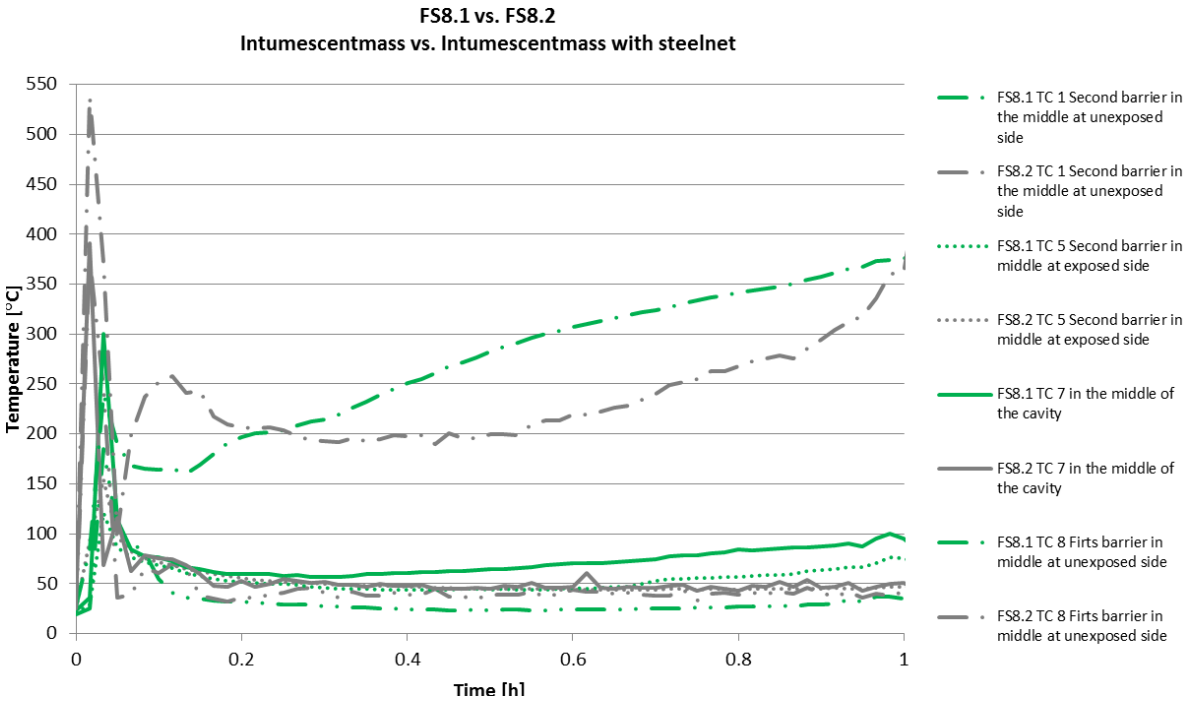


Figure 35. Comparison between cavity FS8.1 and FS8.2, the intumescing mass compared to the intumescing mass with steel net.

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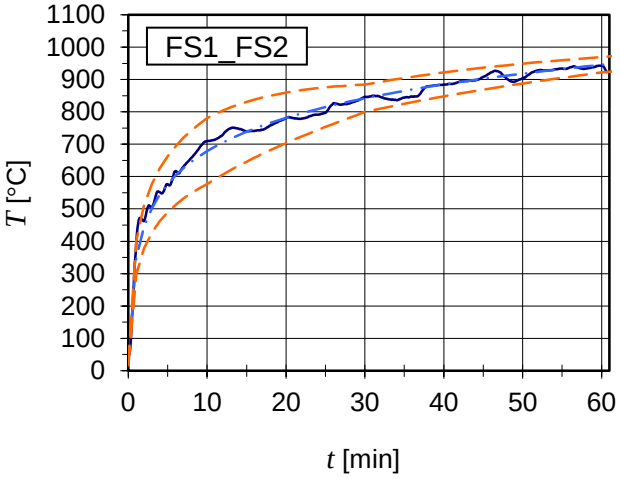
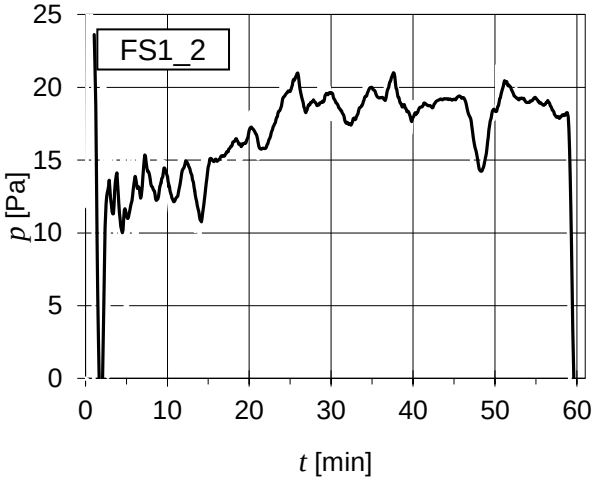
Wood Building Technology

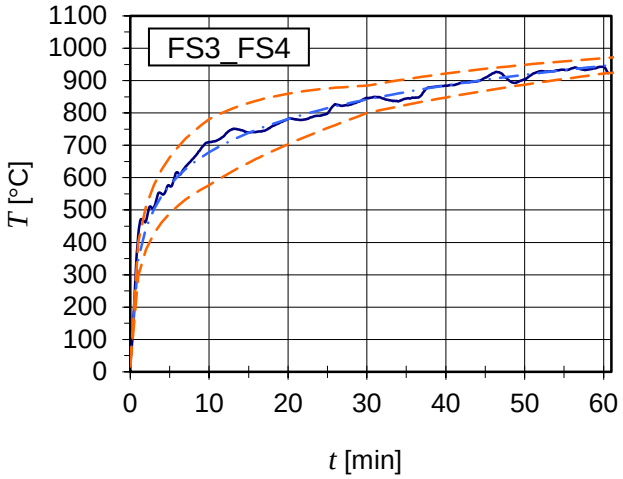
Performed by	Checked by
Alar Just Researcher	Karin Sandberg Section manager

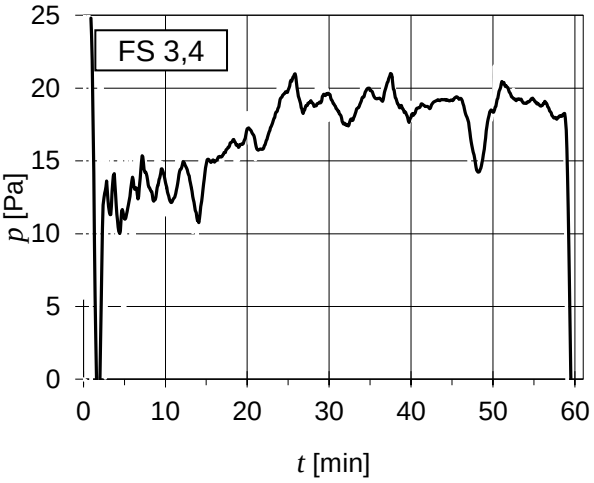
Appendices

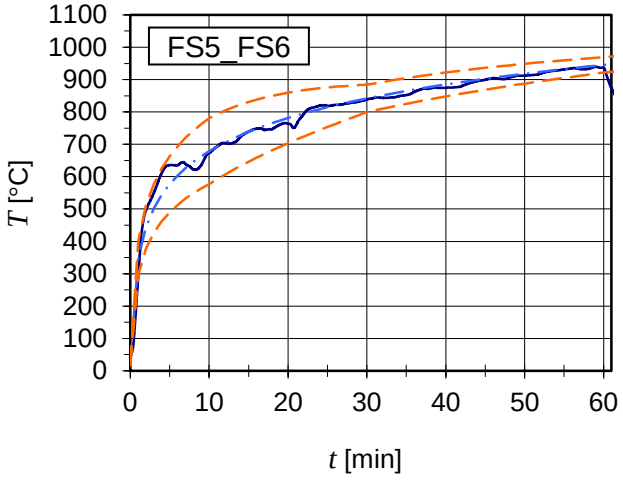
Annex A. Furnace data

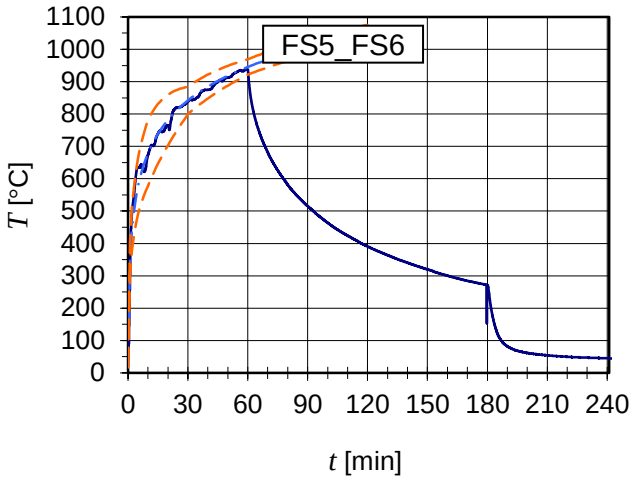


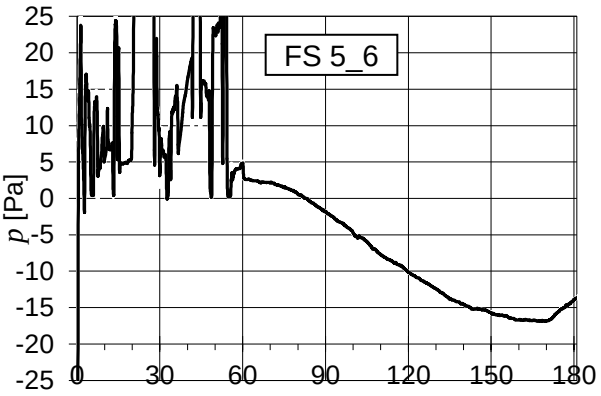


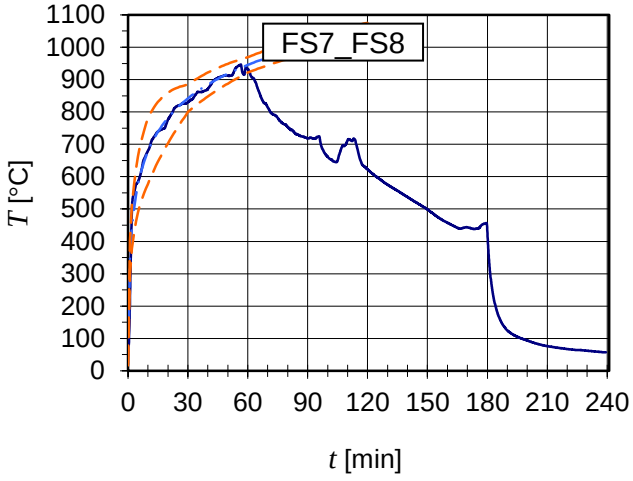

FS3_FS4
T [°C]
t [min]
0
100
200
300
400
500
600
700
800
900
1000
1100
0
10
20
30
40
50
60

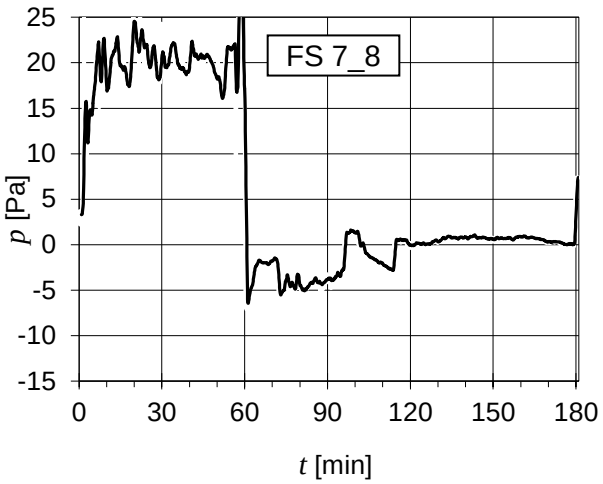

FS 3,4
p [Pa]
t [min]
0
5
10
15
20
25
0
10
20
30
40
50
60


FS5_FS6
T [°C]
t [min]
0
100
200
300
400
500
600
700
800
900
1000
1100
0
10
20
30
40
50
60


FS5_FS6
T [°C]
t [min]


FS 5_6
p [Pa]
t [min]


FS7_FS8
T [°C]
t [min]


FS 7_8
25
20
15
10
5
0
-5
-10
-15
p [Pa]
0
30
60
90
120
150
180
t [min]

Appendix 1