BRE Global Client Report

Characterisation of medium fire exposure fuel source

Prepared for: European Commission
Date: 06.09.2021
Report Number: P117805-1000 Issue: 1

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Prepared for:
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The report describes the first phase of the calibration exercise using the medium fire exposure, part of the European project “Finalization of the European approach to assess the fire performance of facades”.

The experiments were performed on a masonry test rig made of concrete blocks comprising the main wall and a perpendicular wing wall. The main wall was 3500mm wide and the wing wall was 1500mm wide, with a total height of the construction of 8500mm.

The fuel source consisted of specified wood sticks positioned inside the combustion chamber on a perforated steel platform. The combustion chamber was located at the intersection between the main wall and wing wall, 500mm above the ground and with the general dimensions of 1000mm height x 1000mm width x 800m depth. The internal walls of the combustion chamber were lined with ceramic fibre. On the back wall of the combustion chamber, a 300mm diameter vent was installed to provide additional airflow with a range of 400±40m$^3$/h.

The experimental programme consists of a series of 10 experiments incorporating variations of different parameters. In the first phase of the calibration procedure, 5 experiments have been performed using the same fuel source with predefined parameters. An additional test D0 was performed to verify the instrumentation installed onto the test rig and the results are presented in the current report. For the second phase of the calibration exercise, some of the variables and parameters to be used in the test have not yet been decided by the project group members.

A series of instruments used to measure the gas-phase temperature, the radiative incident heat flux, and the mass loss of the fuel source during the exposure have been installed onto the test rig. The measurements over time for each test are presented in the main body of this report. A comparative analysis of selected parameters for the tests performed is presented showing the influence of various parameters.
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Introduction

The experiments described in this document are part of the European project “Finalization of the European approach to assess the fire performance of facades”. This project aims to develop a harmonized methodology to assess the performance of façade systems when exposed to fire.

A series of tests were proposed to evaluate the thermal exposure on the façade under various conditions as shown in Table 1.

Table 1 Proposed experimental programme and the associated parameters

<table>
<thead>
<tr>
<th>Test ref.</th>
<th>Wood crib parameters</th>
<th>Fire exposure</th>
<th>Air flow (m³/h)</th>
<th>Wind speed (m³/s)</th>
<th>Uplift (m)</th>
<th>Secondary opening location</th>
<th>Test specimen</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td></td>
<td>Medium</td>
<td>400</td>
<td>0.5</td>
<td>0.5</td>
<td>Eccentrically</td>
<td>Inert</td>
</tr>
<tr>
<td>D2</td>
<td></td>
<td>Medium</td>
<td>400</td>
<td>0.5</td>
<td>0.5</td>
<td>Eccentrically</td>
<td>Inert</td>
</tr>
<tr>
<td>D3</td>
<td></td>
<td>Medium</td>
<td>400</td>
<td>0.5</td>
<td>0.5</td>
<td>Eccentrically</td>
<td>Inert</td>
</tr>
<tr>
<td>E1</td>
<td></td>
<td>Medium</td>
<td>360</td>
<td>0.5</td>
<td>0.5</td>
<td>Eccentrically</td>
<td>Inert</td>
</tr>
<tr>
<td>E2</td>
<td></td>
<td>Medium</td>
<td>440</td>
<td>0.5</td>
<td>0.5</td>
<td>Eccentrically</td>
<td>Inert</td>
</tr>
<tr>
<td>F1 (4)</td>
<td></td>
<td>Medium</td>
<td>420</td>
<td>0.5</td>
<td>0.5</td>
<td>Eccentrically</td>
<td>Inert</td>
</tr>
<tr>
<td>F2 (4)</td>
<td></td>
<td>Medium</td>
<td>420</td>
<td>0.5</td>
<td>0.5</td>
<td>Eccentrically</td>
<td>Inert</td>
</tr>
<tr>
<td>K1</td>
<td></td>
<td>Medium</td>
<td>400</td>
<td>0.5</td>
<td>0.5</td>
<td>Eccentrically</td>
<td>TBC</td>
</tr>
<tr>
<td>K2</td>
<td></td>
<td>Medium</td>
<td>400</td>
<td>0.5</td>
<td>0.5</td>
<td>Symmetrically</td>
<td>TBC</td>
</tr>
<tr>
<td>K3</td>
<td></td>
<td>Medium</td>
<td>400</td>
<td>0.5</td>
<td>0.5</td>
<td>Without</td>
<td>TBC</td>
</tr>
</tbody>
</table>

This test report summarises the tests D1-E2 carried out to date on the medium exposure. The remaining tests F1 (4)-K3 will be performed in the second phase of this experimental study.
Description of the project

Test rig description

The test rig consists of a main wall and wing wall made of concrete blocks with a density of 650±200kg/m³ and with a total height of 8500mm. The main wall has a width of 3500mm, and the wing wall has a width of 1500mm. In the medium fire exposure scenario, the fuel source is wood cribs placed inside a combustion chamber located at the bottom of the test rig, flush with the wing wall. The combustion chamber is raised 500mm from the floor and has internal dimensions of 1000mm height x 1000mm width x 800mm depth. The internal walls of the combustion chamber are lined with ceramic fibre insulation with a thickness of 25mm. On the back wall of the combustion chamber, an air supply inlet is present with a diameter of 300mm located centrally, capable of providing 400±40m³/h volume of air.

A general representation of the combustion chamber (vertical and horizontal section) and the position of the wood crib is shown in Figure 1.

![Figure 1: Vertical and horizontal section through the combustion chamber](image)

Fuel source

The fuel source consisted of timber sticks 500±10mm long with an average density of 475±25kg/m³. The sticks were of rectangular section 40±1mm x 40±1mm, with a moisture content of 11±2%. The timber crib was built using 6 sticks/layer positioned equidistantly. The number of layers or the sticks of the top layer has been adjusted in such a way that the total mass of the wood crib was within the specified tolerances (30±1.5kg). The sticks forming the wood crib were nailed together following the specifications. The wood crib was placed inside the combustion chamber on a steel platform.

The crib was placed on a steel platform, in such a way that the base of the crib was raised 200±5mm above the floor level of the combustion chamber. The top side of the platform was made of a steel mesh 40mmx40mm to allow for ventilation from the bottom. The front side of the crib was located at 100 ± 10mm behind the front elevation of the test rig. The distance between the crib and the sidewalls on both sides was 250mm. The detailed design of the wood crib platform is shown in Appendix A.
Instrumentation

The test rig incorporated a number of instruments positioned on the main and wing wall to measure the gas-phase temperature and the incident radiative heat flux during the fire exposure, at various locations as shown in Figure 2. The gas-phase temperature measurements were made with 1.5mm diameter sheathed thermocouples positioned 50mm away from the face of the test rig. The incident radiative heat flux was measured using water-cooled Schmidt Boelter type gauges positioned 1000mm away in front of the rig and on the height of the test rig, corresponding with the centreline of the combustion chamber as shown in Figure 2.

![Instrumentation plan for the experiments](image)

A load cell platform (scale) with an accuracy of ±0.01kg was used to continuously measure the mass loss of the timber crib throughout the fuel load combustion period. The scale was positioned under the floor of the combustion chamber and protected accordingly to avoid any potential heat damage. The measurements were continuously collected at 10 seconds intervals.
Wood cribs

A number of cribs were prepared for the tests performed in this phase of the experimental programme D1-E2. The main parameters of the cribs are listed in the table below. The wood crib D0 was used for an additional test to check the consistency of the measurements and it will be presented as an addition to the main testing programme. The density and the moisture content measurements were made of 10 sticks from each wood crib and the average values are shown in the table below.

Table 2 Average parameters for the wood cribs used

<table>
<thead>
<tr>
<th>Crib</th>
<th>Average density (Kg/m³)</th>
<th>Average moisture content (%)</th>
<th>Total mass (Kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D0</td>
<td>508</td>
<td>11.3</td>
<td>30.5</td>
</tr>
<tr>
<td>D1</td>
<td>497</td>
<td>11.6</td>
<td>29.6</td>
</tr>
<tr>
<td>D2</td>
<td>504</td>
<td>12.5</td>
<td>32.9</td>
</tr>
<tr>
<td>D3</td>
<td>499</td>
<td>11.8</td>
<td>32.5</td>
</tr>
<tr>
<td>E1</td>
<td>504</td>
<td>11.9</td>
<td>32.0</td>
</tr>
<tr>
<td>E2</td>
<td>506</td>
<td>12.8</td>
<td>30.4</td>
</tr>
</tbody>
</table>

Wood crib environmental condition prior to ignition

These tests part of the current experimental programme were performed indoors, under a controlled environment. The air velocity was checked 5 minutes prior to ignition with the extraction system running and the values measured were below 0.1 m/s. The ambient temperature prior to the test was in the range of +10°C to +30°C.
Findings

Test results D0

D0 was performed to check the test procedure and the instrumentation installed onto the test rig and it was not part of the main experimental programme. The fuel source and the test conditions were the same as tests D1-D3. The results of this test are presented and may be used as additional information for analysis of the results.

In this test, the burnout duration was approximately 32 minutes and the airflow inside the combustion chamber 4 minutes from ignition was 400m³/h.

Figure 3 Flames emerging from the combustion chamber after ignition

Figure 4 shows the time-temperature measurements on the central axis above the combustion chamber throughout the test.

Figure 4 Time-temperature history measured on the central axis
Figure 5, Figure 6, Figure 7 and Figure 8 show the time-temperature history recorded on the horizontal axis at 1.3m, 2.0m, 3.0m and 3.5m above the combustion chamber.

Figure 5 Time-temperature history recorded on the horizontal axis 1.3m above the combustion chamber

Figure 6 Time-temperature history recorded on the horizontal axis 2.0m above the combustion chamber
Figure 7 Time-temperature history recorded on the horizontal axis 3.0m above the combustion chamber

Figure 8 Time-temperature history recorded on the horizontal axis 3.5m above the combustion chamber
The maximum values recorded on the horizontal axis were measured by the instruments 14, 25, 36, and 44 (see Figure 2) positioned at the junction between the main wall and wing wall as shown in Figure 9.

Figure 9 Maximum temperatures recorded on the horizontal axis

Figure 10 shows the incident radiative heat flux measured on the central axis above the combustion chamber at specified heights. An average maximum value of approximately 60kW/m² was measured.

Figure 10 Incident radiative heat flux measured in front and above the combustion chamber
Figure 11 shows the relationship between mass loss and mass loss rate over the crib burning duration of 32 minutes.

![Figure 11 Mass loss and mass loss rate over the burning duration](image)

A summary of the maximum values for horizontal axis temperature and maximum average values for heat flux and mass loss rate recorded over the fire exposure duration is shown in the table below.

Table 3 Summary of selected parameters over the fire exposure duration

<table>
<thead>
<tr>
<th>Instruments</th>
<th>14 (°C)</th>
<th>25 (°C)</th>
<th>36 (°C)</th>
<th>44 (°C)</th>
<th>HF1-2 (kW/m²)</th>
<th>Mass loss rate (Kg/s)</th>
<th>Burnout (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maximum Values Test D0</strong></td>
<td>696.6</td>
<td>560.7</td>
<td>429.2</td>
<td>382</td>
<td>60</td>
<td>0.034</td>
<td>32</td>
</tr>
<tr>
<td><strong>Height from combustion chamber (m)</strong></td>
<td>1.3</td>
<td>2.0</td>
<td>3.0</td>
<td>3.5</td>
<td>1.0</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Test results D1

Test D1 of the experimental programme investigated the burning behaviour of the medium fire exposure crib using selected average parameters for the timber (i.e. moisture content, density, etc.). In this test, the burnout duration was approximately 31 minutes and the airflow inside the combustion chamber after 4 minutes from ignition was 400m$^3$/h.

Figure 12 After ignition of the fuel source

Figure 13 shows the time-temperature measurements on the central axis above the combustion chamber throughout the test.

Figure 13 Time-temperature history measured on the central axis
Figure 14, Figure 15, Figure 16, and Figure 17 show the time-temperature history recorded on the horizontal axis at 1.3m, 2.0m, 3.0m and 3.5m above the combustion chamber.

Figure 14 Time-temperature history recorded on the horizontal axis 1.3m above the combustion chamber

Figure 15 Time-temperature history recorded on the horizontal axis 2.0m above the combustion chamber
Figure 16 Time-temperature history recorded on the horizontal axis 3.0m above the combustion chamber

Figure 17 Time-temperature history recorded on the horizontal axis 3.5m above the combustion chamber
The maximum values recorded on the horizontal axis were measured by the instruments 14, 25, 36, and 44 (see Figure 2) positioned at the junction between the main wall and wing wall as shown in Figure 18.

![Figure 18 Maximum temperatures recorded on the horizontal axis](image)

Figure 18 Maximum temperatures recorded on the horizontal axis

Figure 19 shows the incident radiative heat flux measured on the central axis above the combustion chamber at specified heights. An average maximum value of approximately 50kW/m² was measured.

![Figure 19 Incident radiative heat flux measured in front and above the combustion chamber](image)
Figure 20 shows the relationship between mass loss and mass loss rate over the crib burning duration of 31 minutes.

![Figure 20 Mass loss and mass loss rate over the burning duration](image)

A summary of the maximum values for horizontal axis temperature and maximum average values for heat flux and mass loss rate recorded over the fire exposure duration is shown in the table below.

**Table 4 Summary of selected parameters over the fire exposure duration**

<table>
<thead>
<tr>
<th>Instruments</th>
<th>14 (°C)</th>
<th>25 (°C)</th>
<th>36 (°C)</th>
<th>44 (°C)</th>
<th>HF1-2 (kW/m²)</th>
<th>Mass loss rate (Kg/s)</th>
<th>Burnout (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maximum Values Test D1</strong></td>
<td>607.4</td>
<td>487.7</td>
<td>382</td>
<td>336</td>
<td>50</td>
<td>0.029</td>
<td>31</td>
</tr>
<tr>
<td><strong>Height from combustion chamber (m)</strong></td>
<td>1.3</td>
<td>2.0</td>
<td>3.0</td>
<td>3.5</td>
<td>1.0</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Test results D2

Test D2 of the experimental programme was a repeat of test D1 with all parameters kept constant. In this test, the burnout duration was approximately 29 minutes and the airflow inside the combustion chamber after 4 minutes from ignition was 400m$^3$/h.

![Ignition and flames emerging from the combustion chamber](image)

Figure 21 Ignition (left) and flames emerging from the combustion chamber after 4 minutes when additional air is supplied inside the combustion chamber (right)

Figure 22 shows the time-temperature measurements on the central axis above the combustion chamber throughout the test.

![Time-temperature history](image)

Figure 22 Time-temperature history measured on the central axis
Figure 23, Figure 24, Figure 25, and Figure 26 show the time-temperature history recorded on the horizontal axis at 1.3m, 2.0m, 3.0m and 3.5m above the combustion chamber.

![Figure 23](image)

**Figure 23 Time-temperature history recorded on the horizontal axis 1.3m above the combustion chamber**

![Figure 24](image)

**Figure 24 Time-temperature history recorded on the horizontal axis 2.0m above the combustion chamber**
Figure 25 Time-temperature history recorded on the horizontal axis 3.0m above the combustion chamber

Figure 26 Time-temperature history recorded on the horizontal axis 3.5m above the combustion chamber
The maximum values recorded on the horizontal axis were measured by the instruments 14, 25, 36, and 44 (see Figure 2) positioned at the junction between the main wall and wing wall as shown in Figure 27.

![Figure 27 Maximum temperatures recorded on the horizontal axis](image)

Figure 27 Maximum temperatures recorded on the horizontal axis

Figure 28 shows the incident radiative heat flux measured on the central axis above the combustion chamber at specified heights. An average maximum value of approximately 80kW/m² was measured.

![Figure 28 Incident radiative heat flux measured in front and above the combustion chamber](image)
Figure 29 shows the relationship between mass loss and mass loss rate over the crib burning duration of 29 minutes.

![Figure 29 Mass loss and mass loss rate over the burning duration](image)

A summary of the maximum values for horizontal axis temperature and maximum average values for heat flux and mass loss rate recorded over the fire exposure duration is shown in the table below.

**Table 5 Summary of selected parameters over the fire exposure duration**

<table>
<thead>
<tr>
<th>Instruments</th>
<th>14 (°C)</th>
<th>25 (°C)</th>
<th>36 (°C)</th>
<th>44 (°C)</th>
<th>HF1-2 (kW/m²)</th>
<th>Mass loss rate (Kg/s)</th>
<th>Burnout (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Values Test D2</td>
<td>695.4</td>
<td>547.2</td>
<td>394.9</td>
<td>346.9</td>
<td>80</td>
<td>0.044</td>
<td>29</td>
</tr>
<tr>
<td>Height from combustion chamber (m)</td>
<td>1.3</td>
<td>2.0</td>
<td>3.0</td>
<td>3.5</td>
<td>1.0</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Test results D3

Test D3 of the experimental programme was a repeat of tests D1 and D2 with all parameters kept constant. In this test, the burnout duration was approximately 31 minutes and the airflow inside the combustion chamber after 4 minutes from ignition was 400 m$^3$/h.

Figure 30 Flames emerging from the combustion chamber after 4 minutes when additional air is supplied inside the combustion chamber (left) and shape of the plume (right).

Figure 31 shows the time-temperature measurements on the central axis above the combustion chamber throughout the test.

Figure 31 Time-temperature history measured on the central axis
Figure 32, Figure 33, Figure 34, and Figure 35 show the time-temperature history recorded on the horizontal axis at 1.3m, 2.0m, 3.0m and 3.5m above the combustion chamber.

Figure 32 Time-temperature history recorded on the horizontal axis 1.3m above the combustion chamber.

Figure 33 Time-temperature history recorded on the horizontal axis 2.0m above the combustion chamber.
Figure 34 Time-temperature history recorded on the horizontal axis 3.0m above the combustion chamber

Figure 35 Time-temperature history recorded on the horizontal axis 3.5m above the combustion chamber
The maximum values recorded on the horizontal axis were measured by the instruments 14, 25, 36, and 44 (see Figure 2) positioned at the junction between the main wall and wing wall as shown in Figure 36.

![Figure 36 Maximum temperatures recorded on the horizontal axis](image)

Figure 36 Maximum temperatures recorded on the horizontal axis

Figure 37 shows the incident radiative heat flux measured on the central axis above the combustion chamber at specified heights. An average maximum value of approximately 49kW/m² was measured.

![Figure 37 Incident radiative heat flux measured in front and above the combustion chamber](image)
Figure 38 shows the relationship between mass loss and mass loss rate over the crib burning duration of 31 minutes.

![Figure 38: Mass loss and mass loss rate over the burning duration](image)

A summary of the maximum values for horizontal axis temperature and maximum average values for heat flux and mass loss rate recorded over the fire exposure duration is shown in the table below.

**Table 6 Summary of selected parameters over the fire exposure duration**

<table>
<thead>
<tr>
<th>Instruments</th>
<th>14 (°C)</th>
<th>25 (°C)</th>
<th>36 (°C)</th>
<th>44 (°C)</th>
<th>HF1-2 (kW/m²)</th>
<th>Mass loss rate (Kg/s)</th>
<th>Burnout (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Values Test D3</td>
<td>652.6</td>
<td>526.2</td>
<td>387.2</td>
<td>346.2</td>
<td>49</td>
<td>0.038</td>
<td>31</td>
</tr>
<tr>
<td>Height from combustion chamber (m)</td>
<td>1.3</td>
<td>2.0</td>
<td>3.0</td>
<td>3.5</td>
<td>1.0</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Test results E1

Test E1 of the experimental programme investigated the burning behaviour of the medium fire exposure crib using selected average parameters for the timber (i.e. moisture content, density, etc.) and using a variation of the air supply inside the combustion chamber.

In this test, the burnout duration was approximately 34 minutes and the airflow inside the combustion chamber after 4 minutes from ignition was 360m$^3$/h.

Figure 39 After ignition (left) and flames emerging from the combustion chamber after 4 minutes when additional air is supplied inside the combustion chamber (right)

Figure 40 shows the time-temperature measurements on the central axis above the combustion chamber throughout the test.
Figure 41, Figure 42, Figure 43, and Figure 44 show the time-temperature history recorded on the horizontal axis at 1.3m, 2.0m, 3.0m and 3.5m above the combustion chamber.

Figure 41 Time-temperature history recorded on the horizontal axis 1.3m above the combustion chamber

Figure 42 Time-temperature history recorded on the horizontal axis 2.0m above the combustion chamber
Figure 43 Time-temperature history recorded on the horizontal axis 3.0m above the combustion chamber

Figure 44 Time-temperature history recorded on the horizontal axis 3.5m above the combustion chamber
The maximum values recorded on the horizontal axis were measured by the instruments 13, 25, 36, and 44 (see Figure 2) positioned at the junction between the main wall and wing wall as shown in Figure 45.

Figure 45 Maximum temperatures recorded on the horizontal axis

Figure 46 shows the incident radiative heat flux measured on the central axis above the combustion chamber at specified heights. An average maximum value of approximately 60kW/m² was measured.

Figure 46 Incident radiative heat flux measured in front and above the combustion chamber
Figure 47 shows the relationship between mass loss and mass loss rate over the crib burning duration of 34 minutes.

![Figure 47 Mass loss and mass loss rate over the burning duration](image)

A summary of the maximum values for horizontal axis temperature and maximum average values for heat flux and mass loss rate recorded over the fire exposure duration is shown in the table below.

**Table 7 Summary of selected parameters over the fire exposure duration**

<table>
<thead>
<tr>
<th>Instruments</th>
<th>14 (°C)</th>
<th>25 (°C)</th>
<th>36 (°C)</th>
<th>44 (°C)</th>
<th>HF1-2 (kW/m²)</th>
<th>Mass loss rate (Kg/s)</th>
<th>Burnout (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Values Test E1</td>
<td>559.6</td>
<td>454.6</td>
<td>345.1</td>
<td>303.5</td>
<td>60</td>
<td>0.032</td>
<td>34</td>
</tr>
<tr>
<td>Height from combustion chamber (m)</td>
<td>1.3</td>
<td>2.0</td>
<td>3.0</td>
<td>3.5</td>
<td>1.0</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

The maximum temperature value recorded for the horizontal axis positioned 1.3m above the combustion chamber was 640°C measured with instrument no. 13. However, for the consistency of the data, the value for instrument number 14 is shown in the table above.
Test results E2

Test E2 of the experimental programme investigated the burning behaviour of the medium fire exposure crib using selected average parameters for the timber (i.e. moisture content, density, etc.) and using a variation of the air supply inside the combustion chamber.

In this test, the burnout duration was approximately 29 minutes and the airflow inside the combustion chamber after 4 minutes from ignition was 440m$^3$/h.

Figure 48 After ignition (left) and flames emerging from the combustion chamber after 4 minutes when additional air is supplied inside the combustion chamber (right)

Figure 49 shows the time-temperature measurements on the central axis above the combustion chamber throughout the test.

Figure 49 Time-temperature history measured on the central axis
Figure 50, Figure 51, Figure 52, and Figure 53 show the time-temperature history recorded on the horizontal axis at 1.3m, 2.0m, 3.0m and 3.5m above the combustion chamber.

Figure 50 Time-temperature history recorded on the horizontal axis 1.3m above the combustion chamber

Figure 51 Time-temperature history recorded on the horizontal axis 2.0m above the combustion chamber
Figure 52 Time-temperature history recorded on the horizontal axis 3.0m above the combustion chamber

Figure 53 Time-temperature history recorded on the horizontal axis 3.5m above the combustion chamber
The maximum values recorded on the horizontal axis were measured by the instruments 14, 25, 36, and 44 (see Figure 2) positioned at the junction between the main wall and wing wall as shown in Figure 54.

![Figure 54 Maximum temperatures recorded on the horizontal axis](image)

Figure 54 Maximum temperatures recorded on the horizontal axis

Figure 55 shows the incident radiative heat flux measured on the central axis above the combustion chamber at specified heights. An average maximum value of approximately 85kW/m² was measured.

![Figure 55 Incident radiative heat flux measured in front and above the combustion chamber](image)
Figure 56 shows the relationship between mass loss and mass loss rate over the crib burning duration of 29 minutes.

![Figure 56 Mass loss and mass loss rate over the burning duration](image)

A summary of the maximum values for horizontal axis temperature and maximum average values for heat flux and mass loss rate recorded over the fire exposure duration is shown in the table below.

**Table 8 Summary of selected parameters over the fire exposure duration**

<table>
<thead>
<tr>
<th>Instruments</th>
<th>14 (°C)</th>
<th>25 (°C)</th>
<th>36 (°C)</th>
<th>44 (°C)</th>
<th>HF1-2 (kW/m²)</th>
<th>Mass loss rate (Kg/s)</th>
<th>Burnout (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Values Test E2</td>
<td>702.7</td>
<td>566.2</td>
<td>403.4</td>
<td>362.8</td>
<td>85</td>
<td>0.048</td>
<td>29</td>
</tr>
<tr>
<td>Height from combustion chamber (m)</td>
<td>1.3</td>
<td>2.0</td>
<td>3.0</td>
<td>3.5</td>
<td>1.0</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Test results summary

In this section, a comparative analysis of selected parameters is presented. Figure 57 shows the recorded heat flux 1m away, in front of the combustion chamber. Figure 58 shows the incident heat flux measured on the centre axis 1.0m above the combustion chamber.

Figure 57 Incident heat flux measured in front of the combustion chamber

Figure 58 Incident heat flux measured 1.0m above the combustion chamber
Figure 59 shows the incident heat flux measured on the centre axis 2.0m above the combustion chamber. Figure 60 shows the incident heat flux measured on the centre axis 3.5m above the combustion chamber. Figure 61 shows the incident heat flux measured on the centre axis 6.5m above the combustion chamber.

Figure 59 Incident heat flux measured 2.0m above the combustion chamber

Figure 60 Incident heat flux measured 3.5m above the combustion chamber
The mass variation and mass-loss rate during the fire exposure for the tests performed are shown in Figure 62 and Figure 63.
Figure 63 Mass loss rate in relation with time during the fire exposure

Figure 64 shows a comparison between the plate thermocouples measurements at the lintel position (0m) above the combustion chamber for the tests performed.
Figure 65 shows a comparison between the plate thermocouples measurements at 1.0m above the combustion chamber for the tests performed.

![Figure 65 Plate thermocouples measurements at 1.0m above the combustion chamber](image)

Figure 66 shows a comparison between the plate thermocouples measurements at the window location 2.0m above the combustion chamber for the tests performed.

![Figure 66 Plate thermocouples measurements at the window position 2.0m above the combustion chamber](image)
Figure 67 shows a comparison between the plate thermocouples measurements at 2.0m above the combustion chamber for the tests performed.

Figure 67 Plate thermocouples measurements at 2.0m above the combustion chamber

Figure 68 shows a comparison between the plate thermocouples measurements at 3.5m above the combustion chamber for the tests performed.

Figure 68 Plate thermocouples measurements at 3.5m above the combustion chamber
A summary of the maximum recorded temperatures along the horizontal instrument axis, average maximum heat flux and the mass loss rate is shown in the table below.

Table 9 Summary of selected parameters over the fire exposure duration

<table>
<thead>
<tr>
<th>Instruments/Measurements</th>
<th>14 (°C)</th>
<th>25 (°C)</th>
<th>36 (°C)</th>
<th>44 (°C)</th>
<th>HF1-2 (kW/m²)</th>
<th>Mass loss rate (Kg/s)</th>
<th>Burnout (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Values Test D0</td>
<td>696.6</td>
<td>560.7</td>
<td>429.2</td>
<td>382</td>
<td>60</td>
<td>0.034</td>
<td>32</td>
</tr>
<tr>
<td>Maximum Values Test D1</td>
<td>607.4</td>
<td>487.7</td>
<td>382</td>
<td>336</td>
<td>50</td>
<td>0.029</td>
<td>31</td>
</tr>
<tr>
<td>Maximum Values Test D2</td>
<td>695.4</td>
<td>547.2</td>
<td>394.9</td>
<td>346.9</td>
<td>80</td>
<td>0.044</td>
<td>29</td>
</tr>
<tr>
<td>Maximum Values Test D3</td>
<td>652.6</td>
<td>526.2</td>
<td>387.2</td>
<td>346.2</td>
<td>49</td>
<td>0.038</td>
<td>31</td>
</tr>
<tr>
<td>Maximum Values Test E1</td>
<td>559.6</td>
<td>454.6</td>
<td>345.1</td>
<td>303.5</td>
<td>60</td>
<td>0.032</td>
<td>34</td>
</tr>
<tr>
<td>Maximum Values Test E2</td>
<td>702.7</td>
<td>566.2</td>
<td>403.4</td>
<td>362.8</td>
<td>85</td>
<td>0.048</td>
<td>29</td>
</tr>
<tr>
<td>Height from combustion chamber (m)</td>
<td>1.3</td>
<td>2.0</td>
<td>3.0</td>
<td>3.5</td>
<td>1.0</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Conclusions

The report describes the first phase of the calibration exercise using the medium fire exposure, part of the European project “Finalization of the European approach to assess the fire performance of facades”.

The experiments were performed on a masonry test rig made of concrete blocks comprising the main wall and a perpendicular wing wall. The main wall was 3500mm wide and the wing wall was 1500mm wide, with a total height of the construction of 8500mm.

The fuel source consisted of specified wood sticks positioned inside the combustion chamber on a perforated steel platform. The combustion chamber was located at the intersection between the main wall and wing wall, 500mm above the ground and with the general dimensions of 1000mm height x 1000mm width x 800m depth. The internal walls of the combustion chamber were lined with ceramic fibre. On the back wall of the combustion chamber, a 300mm diameter vent was installed to provide additional airflow with a range of 400±40m³/h.

The experimental programme consists of a series of 10 experiments incorporating variations of different parameters. In the first phase of the calibration procedure, 5 experiments have been performed using the same fuel source with predefined parameters. An additional test D0 was performed to verify the instrumentation installed onto the test rig and the results are presented in the current report. For the second phase of the calibration exercise, some of the variables and parameters to be used in the test have not yet been decided by the project group members.

A series of Instruments used to measure the gas-phase temperature, the radiative incident heat flux, and the mass loss of the fuel source during the exposure have been installed onto the test rig. The measurements over time for each test are presented in the main body of this report. A comparative analysis of selected parameters for the tests performed is presented showing the influence of various parameters.
References

Appendix A  Wood crib platform

Figure 69 Wood crib support platform general dimensions
Appendix B  Additional test data

Figure 70 Temperature distribution on the vertical axis offset on main wall (Test D0)

Figure 71 Temperature distribution on the vertical axis offset on the wing wall (Test D0)
Figure 72 Temperature distribution on the vertical axis offset on main wall (Test D1)

Figure 73 Temperature distribution on the vertical axis offset on the wing wall (Test D1)
Figure 74 Temperature distribution on the vertical axis offset on main wall (Test D2)

Figure 75 Temperature distribution on the vertical axis offset on the wing wall (Test D2)
Figure 76 Temperature distribution on the vertical axis offset on main wall (Test D3)

Figure 77 Temperature distribution on the vertical axis offset on the wing wall (Test D3)
Figure 78 Temperature distribution on the vertical axis offset on main wall (Test E1)

Figure 79 Temperature distribution on the vertical axis offset on the wing wall (Test E1)
Figure 80 Temperature distribution on the vertical axis offset on main wall (Test E2)

Figure 81 Temperature distribution on the vertical axis offset on the wing wall (Test E2)
Figure 82 Comparison of plate thermocouples measurements at 6.5m above the combustion chamber

Figure 83 Comparison of gas-phase thermocouples 1.3m above the combustion chamber
Figure 84 Comparison of gas-phase thermocouples 2.0m above the combustion chamber

Figure 85 Comparison of gas-phase thermocouples 3.0m above the combustion chamber
Figure 86 Comparison of gas-phase thermocouples 3.5m above the combustion chamber