



# Reaction-to-fire report

A reaction-to-fire test of a non-loadbearing external wall system in  
accordance with BS 8414-2:2015+A1:2017

Test sponsor: Victorian Building Authority

Product: Rendered expanded polystyrene clad wall system

Job number: RTF190234

Test date: 4 June 2020      Revision: R1.1

## Quality management

| Version | Date            | Information about the report |                                                                                                                                  |                                                                                    |                                                                                     |
|---------|-----------------|------------------------------|----------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| R1.0    | 30 July 2020    | Description                  | Initial issue                                                                                                                    |                                                                                    |                                                                                     |
|         |                 |                              | Prepared by                                                                                                                      | Reviewed by                                                                        | Authorised by                                                                       |
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| R1.1    | 9 December 2020 | Description                  | Correction to the stated construction date in Table 7 and further specification of the material properties of item 1 of Table 5. |                                                                                    |                                                                                     |
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## Executive summary

This report documents the findings of the reaction-to-fire test for a non-loadbearing external wall system undertaken on 4 June 2020 in accordance with BS 8414-2:2015.

Warringtonfire Australia did the test at the request of Victorian Building Authority.

Table 1 provides a summary of the test specimen. A summary of the results is provided in Table 2.

**Table 1 Test specimen**

| Item          | Detail                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Test specimen | The wall system was a timber framed wall clad with expanded polystyrene (EPS) panels on the exposed (external) side. The EPS panels had a render applied to it over the external face. Regular plasterboard was used to clad the unexposed (internal) side of the wall. The timber framing was built into three floor levels whilst the EPS panels and render ran continuously, except for a horizontal control joint running across the width of the system, 4.4 mm above ground level. The wall system was ~10 m tall and 207 mm thick. There main wall was ~2.8 m wide and the wing wall was ~1.5 m wide. |

**Table 2 Test results**

| Parameter                                        | Results                                                                                                        |
|--------------------------------------------------|----------------------------------------------------------------------------------------------------------------|
| Test Duration                                    | 12 minutes 12 seconds<br>The test was stopped due to flames extending above the top of the test apparatus.     |
| $t_s$ , start time                               | 3 minutes 50 seconds after ignition of crib                                                                    |
| Peak temperature/time at Level 2, 50 mm external | 979 °C at 8 minutes 15 seconds after $t_s$ .<br>There was a temperature rise exceeding 600 °C for 30 seconds.  |
| Peak temperature/time at Level 2, panel layer    | 1000 °C at 8 minutes 15 seconds after $t_s$ .<br>There was a temperature rise exceeding 600 °C for 30 seconds. |
| Peak temperature/time at Level 2, frame cavity   | 978 °C at 8 minutes 15 seconds after $t_s$ .<br>There was a temperature rise exceeding 600 °C for 30 seconds.  |
| Peak temperature/time at Level 1, 50 mm external | 994 °C at 8 minutes 05 seconds after $t_s$                                                                     |
| Peak temperature/time at 900 mm above lintel     | 106 °C at 8 minutes 20 seconds after $t_s$                                                                     |
| Peak temperature/time at 1400 mm above lintel    | 100 °C at 8 minutes 20 seconds after $t_s$                                                                     |
| Flaming on the unexposed side                    | There was no flaming on the unexposed side of the specimen.                                                    |
| Openings to the unexposed side                   | No openings to the unexposed side of the specimen were created.                                                |
| Flame spread                                     | Flame spread reached to the top of the specimen.                                                               |
| Flaming debris                                   | There was continuously flaming debris on the ground floor for a 5 minute 25 second period.                     |
| Mass of measured debris                          | 12.96 kg                                                                                                       |

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## 1. Introduction

This report documents the findings of the reaction-to-fire test for a non-loadbearing external wall system undertaken on 4 June 2020 in accordance with BS 8414-2:2015.

Warringtonfire Australia did the test at the request of test sponsors listed in Table 3.

**Table 3** Test sponsor details

| Test sponsor                 | Address                                                                     |
|------------------------------|-----------------------------------------------------------------------------|
| Victorian Building Authority | Goods Shed North<br>733 Bourke Street<br>Docklands<br>VIC 3008<br>Australia |

## 2. Test specimen

### 2.1 Schedule of components

Table 5 describes the test specimen and lists the schedule of components. Materials for the build were sourced and surveyed by Warringtonfire Australia at the request of the test sponsor.

A full description of the test specimen is provided in the drawings included in Appendix A.

**Table 4** Test assembly

| Item                                      | Detail          |          |
|-------------------------------------------|-----------------|----------|
| Non-loadbearing timber framed wall system | Height (h):     | 10020 mm |
|                                           | Thickness(t):   | 207 mm   |
| Width of main wall finished face          | 2815 mm         |          |
| Width of wing wall finished face          | 1460 mm         |          |
| Meeting point of main wall and wing wall  | Internal corner |          |

**Table 5 Schedule of components**

General Description

To be read in consulting the drawings in Appendix A.

The wall system was built on three floor levels – with an additional partial floor - using steel hollow sections (SHS) as false slabs (item 31). The false slabs were located at approximately 3000 mm vertical centres, as shown in Appendix A - Figure 3 & Figure 4. Within these false slab levels, timber frames (item 3) were screw fixed (item 22) to the false slabs, which were built to the specifications shown in Appendix A - Figure 3 & Figure 4. The lower level of the timber framing was built upon and screw (item 23) fixed into 150 mm tall Hebel blocks (item 32), which were used to simulate a raised concrete slab. The unexposed face of the timber framing was clad with 10 mm thick standard plasterboard (item 2) fixed with plasterboard screws (item 25), with exposed screws and joints base-coated (item 21). The exposed face of the timber framing was weather protected using sarking (item 13) fixed with staples (item 28). Aluminium tape (item 14) was adhered to the sarking on the main wall, vertically in line with the double stud of the timber framing (item 3). Aluminium tape (item 14) was also used around the large orifice at the bottom of the timber framing. The frame (item 3) and sarking (item 13) were then clad with pre-rendered expanded polystyrene (EPS) panels (item 1) fixed with screws and washers (item 27) leaving an opening approximately 2 m by 2 m, at the bottom of the main wall.

The opening was capped with painted timber reveals (item 10) – which were screw fixed (item 25) to the timber framing (item 3). Attached to these timber strips were aluminium extrusions (item 12), that were screw fixed (item 25). These strips created the reveal of the opening with the aluminium extrusions (item 12) representing the perimeter of an aluminium framed window. Packers (item 10) were placed between the reveal (item 10) and the timber framing (item 3). Timber architraves (item 11) were used to cap the opening on the plasterboard (item 2) side of the wall.

The EPS panels (item 1) were screw (item 27) fixed over the top of the sarking (item 13). Panel to panel joints were butt joined with a bead of expandable foam (item 15) used at the centre of the thickness of the panel. The vertical external edges of the main and wing walls were capped with a layer of fire-rated plasterboard (item 9), which was screw (item 24) fixed. Expandable foam (item 15) was applied between the FR-plasterboard (item 9) and the EPS panels (item 1). Mid-width of the 2 m by 2m opening, extending vertically to the top of the specimen, was a 10 mm wide vertical control joint, residing over the aluminium tape (item 14). Parts of the EPS boards (item 1) that ran over the tape had sealant (item 16) applied between the board and the tape – refer to Figure 1, Figure 5 and Figure 9. Approximately 2.4 m above the opening was a horizontal control joint that spanned both main and wing walls. The panels above and below the horizontal control joint were capped with an aluminium starter channel (item 6) and a galvanized steel flashing (item 5), respectively.

To the face of the pre-rendered EPS panels (item 1) was applied render, simultaneously with various reinforcing elements. These reinforcing elements were aluminium beads with a fiberglass mesh (item 8), applied over the FR-plasterboard capping (item 9), – and self-adhesive fiberglass mesh (item 20) – which was applied to panel to panel joints. The render system was then finished off with a topcoat (item 18). Once the topcoat and render system hardened, a backing rod (item 17) and sealant (item 16) were applied to the vertical control joint. Sealant (item 16) was also applied at the corner between the aluminium extrusions (item 12) and the finished render (item 18) at the 2 m by 2 m opening. The top of the specimen was capped with metal rigid capping (item 7) fixed with roofing screws (item 26).

| Item     | Description  |                                                                                                                                                                                                                                                                                                                                                                           |
|----------|--------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Cladding |              |                                                                                                                                                                                                                                                                                                                                                                           |
| 1        | Item name    | External lining                                                                                                                                                                                                                                                                                                                                                           |
|          | Product name | 100 mm thick pre-rendered expanded polystyrene (EPS) panels                                                                                                                                                                                                                                                                                                               |
|          | Material     | Approximately 100 mm thick medium grade expanded polystyrene with a flame-retardant additive and a density of 20 kg/m <sup>3</sup> (verified) with one of the large faces covered by a layer of render with a thickness of approximately 1 mm.<br><br>Within the render covering the entire rendered face was a mesh 0.4 mm in thickness with a 6 mm × 4 mm grid pattern. |
|          | Size         | 2397 mm long × 1197 mm wide × 101 mm thick<br><br>Mass per unit area: 3.4 kg/m <sup>2</sup>                                                                                                                                                                                                                                                                               |

| General Description |              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|---------------------|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                     | Installation | Screw fixed to the timber frame (item 3) with the rendered side of the panels facing away from the timber frame. Fixings were at stud locations with 400 mm vertical screw centres using EPS board screws and washers (item 27). There was a vertical 10 mm gap located central to the 2 m by 2m opening extending vertically up the specimen. At the bottom of the specimen there was a 75 mm EPS panel overhang in front of the Hebel blocks (item 32). See - Figure 5 & Figure 6. |
| 2                   | Item name    | Internal lining                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|                     | Product name | 10 mm thick standard plasterboard                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|                     | Size         | Uncut: 1200 mm wide × 3600 mm or 3000 mm long × 10 mm thick<br>Mass per linear metre: 7.5 kg/m                                                                                                                                                                                                                                                                                                                                                                                       |
|                     | Installation | Screw (item 25) fixed to the timber frame at stud locations with 400 mm vertical screw centres in field and 300 mm centres around the periphery, with a 25 mm offset from the horizontal edges. A 10 mm gap was left at the top and bottom of slab levels between the plasterboard and false slabs (including the Hebel blocks – item 32). This gap was filled with fire-rated sealant (item 19).                                                                                    |
| Framing             |              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 3                   | Item name    | Timber framing                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|                     | Material     | 90 mm × 45 mm MGP10 timber with a density of 430 kg/m <sup>3</sup> and an approximate water content of 9 %.                                                                                                                                                                                                                                                                                                                                                                          |
|                     | Size         | Full frames were approximately 2850 mm tall × 2900 mm wide × 90 mm deep for the main wall and approximately 2850 mm tall × 1635 mm wide × 90 mm deep for the wing wall. Studs were at a max 600 mm centres whilst noggins were at approximate 950 mm centres. At approximately 2.4 m above the combustion chamber opening spanning the width of the main and wing walls was added back blocking. For all details Appendix A.                                                         |
|                     | Installation | Screw (item 22) fixed to the false slabs at the head and base track at max 600 mm centres. The base track on the lower level was fixed (item 23) to the Hebel blocks (item 32).                                                                                                                                                                                                                                                                                                      |
| Flashing/capping    |              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 4                   | Item name    | PVC starter channel                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|                     | Size         | 101 mm deep cavity × 30 mm front flange height × 58 mm back flange height<br>Approximate thickness: 1.3 mm                                                                                                                                                                                                                                                                                                                                                                           |
|                     | Installation | Installed (friction fitted) at the bottom of the lowest panels on the main and wing wall. See Figure 11 and Figure 15.                                                                                                                                                                                                                                                                                                                                                               |
| 5                   | Item name    | Control joint flashing - galvanised steel                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|                     | Size         | 0.6 mm thick × 118 mm deep web with 2 flanges – 52 mm and 20 mm long at ca.111 – 116 ° bend.                                                                                                                                                                                                                                                                                                                                                                                         |
|                     | Installation | Installed on the top of the EPS panels (item 1) below the 2.4 m horizontal control joint. Screw (item 24) fixed at 300 mm centres to the back blocking of the timber framing (item 3). See Figure 13 and Figure 15.                                                                                                                                                                                                                                                                  |
| 6                   | Item name    | Control joint starter channel – aluminium                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|                     | Size         | 0.6 mm thick angled channel with a 110 mm deep web with 2 perforated flanges - 50 mm and 24 mm long at ca.111 – 116 ° bend.                                                                                                                                                                                                                                                                                                                                                          |
|                     | Installation | Installed on the bottom of the EPS panel above the horizontal control joint (4.4 m above the ground). Screw (item 24) fixed at 300 mm centres to the back blocking of the timber framing (item 3). See Figure 13 and Figure 15.                                                                                                                                                                                                                                                      |
| 7                   | Item name    | Rigid Metal Capping – galvanized steel                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|                     | Size         | 0.6 mm thick angled channel with a 212 mm deep web with 2 flanges - 52 mm and 34 mm long with a 9 mm long lip.                                                                                                                                                                                                                                                                                                                                                                       |

| General Description |              |                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|---------------------|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                     | Installation | Installed at the top of the specimen fitted around the rendered wall system and the plasterboard wall, fixed to the timber framing (item 3) using hex-head roofing screws (item 26) and 300 mm centres. See Figure 12 and Figure 15                                                                                                                                                                                               |
| 8                   | Item name    | Corner beads – aluminium with fiberglass mesh                                                                                                                                                                                                                                                                                                                                                                                     |
|                     | Size         | 22 mm × 24 mm × 0.32 mm thick perforated angle. The angle contained Ø8 mm perforations at repeating 12 mm centres on each flange. On the internal corner was fixed an angled fiberglass mesh approximately 85 mm × 115 mm.<br>Mesh: 4 mm × 6 mm grid, 0.4 mm thick, 141 GSM.                                                                                                                                                      |
|                     | Installation | Installed on the sides of the specimen fitted around the rendered wall system and the plasterboard capping (item 9). Was placed in conjunction with the render (item 18). See Appendix A.                                                                                                                                                                                                                                         |
| 9                   | Item name    | Fire-rated plasterboard capping – 13 mm FR-rated PB                                                                                                                                                                                                                                                                                                                                                                               |
|                     | Size         | ~200 mm wide × 13 mm thick<br>Density: 513 kg/m <sup>3</sup>                                                                                                                                                                                                                                                                                                                                                                      |
|                     | Installation | Installed at the outer vertical edges of the main and wing wall, screws fixed (item 24) at 300 mm centres starting from a 100 mm from the edge of the plasterboard – along the length.                                                                                                                                                                                                                                            |
| 10                  | Item name    | Timber reveal and packers                                                                                                                                                                                                                                                                                                                                                                                                         |
|                     | Size         | Vertical reveal timber: 100 mm deep × 18.3 mm thick × 1815 mm tall (vertical). Painted white.<br>Mass per linear metre: 1.25 kg/m<br>Horizontal reveal timber: 100 mm deep × 18.3 mm thick × 2040 mm long (horizontal). Painted white.<br>Mass per linear metre: 1.25 kg/m<br><br>Packers: ~ 6 mm thick (for vertical reveal)<br>Gap: ~ 16 mm high (for horizontal reveal – no packers)                                           |
|                     | Installation | The head of the reveal was screw fixed to the vertical members. To the exposed side of the reveal the aluminium window framing (item 12) was screw fixed (item 25) at approximately 200 mm centres. The reveal assembly was then placed inside the timber framing (item 3) with the packers in between the vertical reveal timber and the timber frame and was screw fixed (item 25) at 300 mm centres. See Figure 7 & Figure 10. |
| 11                  | Item name    | Timber architraves                                                                                                                                                                                                                                                                                                                                                                                                                |
|                     | Size         | 18 mm thick × 36 mm wide<br>Mass per linear metre: 1.25 kg/m                                                                                                                                                                                                                                                                                                                                                                      |
|                     | Installation | Installed around the 2 m by 2 m opening on the plasterboard fixed with brads (item 30) at approximately 300 mm centres. The corners, where the architraves met, were mitred to 45°. See Figure 7 & Figure 10.                                                                                                                                                                                                                     |
| 12                  | Item name    | Aluminium extrusion – window framing                                                                                                                                                                                                                                                                                                                                                                                              |
|                     | Size         | 75 mm total depth × 33 mm visible width × 1.5 mm thick                                                                                                                                                                                                                                                                                                                                                                            |
|                     | Installation | Screw fixed to the exposed side of the timber reveal at ~200 mm centres using plasterboard screws (item 25). See Figure 7 & Figure 10.                                                                                                                                                                                                                                                                                            |
| Sarking             |              |                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 13                  | Item name    | Breathable plastic sarking                                                                                                                                                                                                                                                                                                                                                                                                        |
|                     | Size         | 2750 mm wide × 0.06 mm thick<br>65 GSM                                                                                                                                                                                                                                                                                                                                                                                            |

| General Description     |              |                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-------------------------|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                         | Installation | The sarking was installed horizontally over the timber frame (item 3) with a 200 mm overlap of the top sheet over the bottom. The sarking was fixed using 10 mm staples (item 28) at approximate 200 mm centres around the tracks and up the studs.                                                                                                                                                                                        |
| 14                      | Item name    | Aluminium tape                                                                                                                                                                                                                                                                                                                                                                                                                             |
|                         | Size         | 0.4 mm thick × 80 mm wide                                                                                                                                                                                                                                                                                                                                                                                                                  |
|                         | Installation | Used to tape the sarking (item 13) around the reveal and inline with the double stud.                                                                                                                                                                                                                                                                                                                                                      |
| Render/Sealant/Adhesive |              |                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 15                      | Item name    | Expandable foam                                                                                                                                                                                                                                                                                                                                                                                                                            |
|                         | Material     | Methylenediphenyl diisocyanate-containing foam                                                                                                                                                                                                                                                                                                                                                                                             |
|                         | Installation | Applied:<br>- at the panel to panel (item 1) butt joins.<br>- between the fire-rated plasterboard (item 9) and the EPS panels (item 1).                                                                                                                                                                                                                                                                                                    |
| 16                      | Item name    | Silicone adhesive                                                                                                                                                                                                                                                                                                                                                                                                                          |
|                         | Material     | White weather proofing silicone sealant.                                                                                                                                                                                                                                                                                                                                                                                                   |
|                         | Installation | Applied:<br>- on top of the backing rod (item 17) in the vertical control joint to a depth of 10 mm.<br>- between the panels (item 1) and aluminium tape (item 14)<br>- at the panel (item 1) and the timber reveal (item 10) junction.                                                                                                                                                                                                    |
| 17                      | Item name    | Backing rod                                                                                                                                                                                                                                                                                                                                                                                                                                |
|                         | Material     | Ø15 mm closed cell backing rod                                                                                                                                                                                                                                                                                                                                                                                                             |
|                         | Installation | Applied to the vertical control joint creating a cavity with a depth of 10 mm.                                                                                                                                                                                                                                                                                                                                                             |
| 18                      | Item name    | Render, primer and texture (white)                                                                                                                                                                                                                                                                                                                                                                                                         |
|                         | Material     | Render (grey): High polymer-containing cementitious modified for EPS render with 10 – 35% Portland cement<br>Thickness: Approximately 3 mm<br>Density: 1776 kg/m <sup>3</sup><br><br>Texture (white): A marble/acrylic paint mix.<br>Thickness: Approximately 1 mm<br><br>Total render system (including that of EPS board):<br>Mass per unit area: 6.6 kg/m <sup>2</sup><br>Free moisture content: 1.2 %<br>Thickness: Approximately 5 mm |
|                         | Installation | The render was mixed with water and applied over the EPS panels (item 1) and over the fire-rated plasterboard capping (item 9) in one application. The render was allowed to cure for 4 to 5 days. Then primer was added over the render and allowed to dry for 2 hours. The texture was then applied over the top in one application.                                                                                                     |
| 19                      | Item name    | Fire-rated sealant                                                                                                                                                                                                                                                                                                                                                                                                                         |
|                         | Installation | Applied to the 10 mm gap located between the plasterboard (item 2), timber frame (item 3) and the false slabs and the Hebel blocks (item 32).                                                                                                                                                                                                                                                                                              |
| 20                      | Item name    | Fibreglass mesh – with self-adhesion (Orange)                                                                                                                                                                                                                                                                                                                                                                                              |
|                         | Material     | Fibreglass grid: 5 mm by 5 mm grid.                                                                                                                                                                                                                                                                                                                                                                                                        |

| General Description |              |                                                                                                                                                                                                                                                                                                                        |
|---------------------|--------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                     |              | 200 mm wide × 0.4 mm thick.                                                                                                                                                                                                                                                                                            |
|                     | Installation | Applied in combination with render (item 18) over the EPS panel to panel (item 1) joins.                                                                                                                                                                                                                               |
| 21                  | Item name    | Basecoat and mesh                                                                                                                                                                                                                                                                                                      |
|                     | Material     | Basecoat: An all-purpose premix containing limestone and perlite – 24-hour curing.<br><br>Fibreglass mesh: 50 mm wide. 3 mm × 3 mm grid × 0.3 mm thick – 76 GSM                                                                                                                                                        |
|                     | Installation | Base coat and mesh were applied to plasterboard to plasterboard joins (item 2). The basecoat was applied to visible screw heads (item 25) in the plasterboard (item 2).                                                                                                                                                |
| Fixings             |              |                                                                                                                                                                                                                                                                                                                        |
| 22                  | Item name    | Ø5.4 × 65 mm long hex head (male) screws – 50 mm long thread SDS                                                                                                                                                                                                                                                       |
|                     | Installation | Used to fix the timber framing (item 3) to the false slabs (item 31).                                                                                                                                                                                                                                                  |
| 23                  | Item name    | Ø5.2 × 100 mm long head screws – 50 mm long coarse thread, needle point, Philips drive                                                                                                                                                                                                                                 |
|                     | Installation | Used to fix the timber framing (item 3) to the Hebel blocks (item 32).                                                                                                                                                                                                                                                 |
| 24                  | Item name    | #6 × 45 mm long bugle head screws - coarse thread, needle point, Philips drive                                                                                                                                                                                                                                         |
|                     | Installation | Used to:<br>- fix the horizontal steel flashing (item 5) to the timber framing (item 3)<br>- fix the horizontal joint aluminium starter channel (item 6) to the timber framing (item 3)<br>- fix the FR plasterboard capping (item 9) to the timber framing (item 3)                                                   |
| 25                  | Item name    | #6 × 32 mm long plasterboard screws – coarse thread, needle point                                                                                                                                                                                                                                                      |
|                     | Installation | Used to screw fix:<br>- the plasterboard (item 2) to the timber framing (item 3). Screw centre were 400 mm centres in-field and 300 mm centres around the perimeter.<br>- the vertical reveal members (item 10) to the timber framing (item 3).<br>- the aluminium extrusions (item 12) to the reveal timber (item 10) |
| 26                  | Item name    | Ø6 mm × 65 mm long – 35 mm long thread roofing hex-head screws – SDS, coarse thread.                                                                                                                                                                                                                                   |
|                     | Installation | Used to fix the rigid metal capping (item 7) to the timber framing (item 3) at the top of the specimen.                                                                                                                                                                                                                |
| 27                  | Item name    | EPS board screws with nylon washer                                                                                                                                                                                                                                                                                     |
|                     | Size         | Screw: 130 mm long × Ø5.0 mm class 3, bugle head, needle point<br>Washer: O.D. ~48 mm, I.D. (for screw) 6 mm,<br>min/max thickness: 1 mm/7 mm.                                                                                                                                                                         |
|                     | Installation | Used to fix the EPS panels (item 1) to the timber framing (item 3).                                                                                                                                                                                                                                                    |
| 28                  | Item name    | 10 mm long × 13 mm wide staples                                                                                                                                                                                                                                                                                        |
|                     | Installation | Used to fix the sarking (item 13) to the timber frame (item 3).                                                                                                                                                                                                                                                        |
| 29                  | Item name    | Ø3 mm × 70 mm long nails                                                                                                                                                                                                                                                                                               |
|                     | Installation | Used to fix timber framing (item 3) members together. 2 nails were used at each end of the noggins and at the top and bottoms of each stud.                                                                                                                                                                            |
| 30                  | Item name    | 50 mm long brads                                                                                                                                                                                                                                                                                                       |

| General Description             |              |                                                                                                                                                                                                                                                                                                         |
|---------------------------------|--------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                 | Installation | Used to fix the architraves (item 11) to the plasterboard (item 2) around the 2 m by 2m opening.                                                                                                                                                                                                        |
| Steel substrate and slab levels |              |                                                                                                                                                                                                                                                                                                         |
| 31                              | Item name    | Steel substrate                                                                                                                                                                                                                                                                                         |
|                                 | Size         | The steel substrate was 9300 mm high × 3245 mm wide for the main wall and 9300 mm high × 2000 mm wide for the wing wall                                                                                                                                                                                 |
|                                 | Installation | The substrate consisted of structural steel sections and square hollow sections (SHS). In addition, movable SHS - 150 mm × 150 mm, acting as false slabs were also present. These were located at heights of 3075 mm, 6075 mm and 9075 mm from the ground (measured from the centre of the false slab). |
| 32                              | Item name    | Hebel block                                                                                                                                                                                                                                                                                             |
|                                 | Size         | Uncut block: 150 mm tall × 200 mm deep × 600 mm wide<br>Density: 830 kg/m <sup>3</sup>                                                                                                                                                                                                                  |
|                                 | Installation | Installed below the timber framing (item 3) on the bottom to simulate a raised concrete slab. The blocks were fixed to the floor using Hebel adhesive (item 33). The Hebel was cut to suit the specimen and allow for the test setup. See Figure 14.                                                    |
| 33                              | Item name    | Hebel adhesive                                                                                                                                                                                                                                                                                          |
|                                 | Material     | Containing Quartz, GP cement, limestone and non-hazardous materials                                                                                                                                                                                                                                     |
|                                 | Installation | Mixed with water and used as a paste to secure the Hebel blocks (item 32) to the concrete floor.                                                                                                                                                                                                        |

## 2.2 Installation details

Table 6 lists the installation and orientation details for the test specimen.

**Table 6 Installation and orientation details**

| Item                                                                     | Detail                                                                                                                                                                                                                                                                                                                                                                |
|--------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Start date for construction of the test specimen                         | 11 May 2020                                                                                                                                                                                                                                                                                                                                                           |
| Finish date for construction of the test specimen (not including render) | 19 May 2020                                                                                                                                                                                                                                                                                                                                                           |
| Date of application of render                                            | 20 May 2020                                                                                                                                                                                                                                                                                                                                                           |
| Date of application of topcoat                                           | 25 May 2020                                                                                                                                                                                                                                                                                                                                                           |
| Completion date for construction of the test specimen                    | 25 May 2020                                                                                                                                                                                                                                                                                                                                                           |
| External wall system constructed by                                      | Representatives of Warringtonfire Melbourne                                                                                                                                                                                                                                                                                                                           |
| Orientation                                                              | <p>Asymmetrical: There are rendered EPS panels on the exposed side of the wall that would normally be on the outside of the building and standard plasterboard on the unexposed side that would usually be on the inside of the building.</p> <p>It was confirmed that the system was exposed from the side that would normally face the outside of the building.</p> |

### 3. Test procedure

Table 7 details the test procedure for this reaction-to-fire.

**Table 7 Test procedure**

| Item                                              | Detail                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                         |
|---------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| Statement of compliance                           | The test was performed in accordance with the requirements of BS 8414-2:2015+A1:2017 for a non-loadbearing external cladding system fixed to and supported by a structural steel frame.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                         |
| Variations                                        | The ignition source of the test was constructed from Radiata Pine instead of Pinus Silvestris.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                         |
| Pre-test conditioning                             | <p>The construction of the external wall system was completed on 25 May 2020.</p> <p>Once the construction of the system was completed, the test specimen was protected from adverse environmental conditions.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                         |
| Environmental conditions at the start of the test | Start of the test                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 18 °C                   |
|                                                   | Wind speed                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 0.1 – 0.4 m/s           |
| Ignition source                                   | Crib material                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Softwood (radiata pine) |
|                                                   | Moisture content                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 13.0 %                  |
|                                                   | Density                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 0.49 kg/dm <sup>3</sup> |
| Sampling / specimen selection                     | Materials for the build were sourced and surveyed by Warringtonfire Australia at the request of the test sponsor.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                         |
| Test duration                                     | 12 minutes 12 seconds                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                         |
| Instrumentation and equipment                     | <p>The instrumentation was provided in accordance with BS 8414-2:2015 as follows:</p> <ul style="list-style-type: none"> <li>• All exposed and cavity temperatures were measured by mineral insulated metal sheathed (MIMS) Type K thermocouples with an overall diameter of 1.5 mm with the measuring junction insulated from the sheath.</li> <li>• The unexposed side specimen temperatures were measured by Type K thermocouples with wire diameters less than 0.5 mm soldered to 12 mm diameter × 0.2 mm thick copper discs covered by 30 mm × 30 mm × 2.0 mm thick inorganic insulating pads.</li> <li>• The thermocouple positions are shown in Figure 17 in Appendix C.</li> <li>• The wind speed was measured by an anemometer at Level 2, 1000 mm forward from the centre line of the combustion chamber.</li> <li>• Timber crib moisture was measured by a J2000 Delmhorst moisture meter.</li> </ul> |                         |

## 4. Test measurements and results

Table 8 shows the peak temperatures the test specimen achieved as listed in BS 8414-2:2015.

The temperature measurements for the test specimen are included in Appendix D.

Table 9 in Appendix B includes observations of any significant behaviour of the specimen and details the occurrence of the various performance criteria specified in BS 8414-2:2015+A1:2017.

Photographs of the specimen are included in Appendix E.

**Table 8 Test results**

| Parameter                                                           | Results                                                                                                        |
|---------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|
| Test Duration                                                       | 12 minutes 12 seconds<br>The test was stopped due to flames extending above the top of the test apparatus.     |
| $t_s$ , start time                                                  | 3 minutes 50 seconds after ignition of crib                                                                    |
| Peak temperature/time at Level 2, 50 mm external                    | 979 °C at 8 minutes 15 seconds after $t_s$ .<br>There was a temperature rise exceeding 600 °C for 30 seconds.  |
| Peak temperature/time at Level 2, panel layer                       | 1000 °C at 8 minutes 15 seconds after $t_s$ .<br>There was a temperature rise exceeding 600 °C for 30 seconds. |
| Peak temperature/time at Level 2, frame cavity                      | 978 °C at 8 minutes 15 seconds after $t_s$ .<br>There was a temperature rise exceeding 600 °C for 30 seconds.  |
| Peak temperature/time at Level 1, 50 mm external                    | 994 °C at 8 minutes 05 seconds after $t_s$                                                                     |
| Peak temperature/time on the unexposed side at 900 mm above lintel  | 106 °C at 8 minutes 20 seconds after $t_s$                                                                     |
| Peak temperature/time on the unexposed side at 1400 mm above lintel | 100 °C at 8 minutes 20 seconds after $t_s$                                                                     |
| Flaming on the unexposed side                                       | There was no flaming on the unexposed side of the specimen.                                                    |
| Openings to the unexposed side                                      | No openings to the unexposed side of the specimen were created.                                                |
| Flame spread                                                        | Flame spread reached to the top of the specimen.                                                               |
| Flaming debris                                                      | There was continuously flaming debris on the ground floor for a 5 minute 25 second period.                     |
| Mass of measured debris                                             | 12.96 kg                                                                                                       |

## **5. Application of test results**

### **5.1 Test limitations**

The results of these fire tests may be used to directly assess fire hazard, but it should be recognised that a single test method will not provide a full assessment of fire hazard under all fire conditions.

These results only relate to the behaviour of the specimen of the element of construction under the particular conditions of the test. They are not intended to be the sole criteria for assessing the potential fire performance of the element in use, and they do not necessarily reflect the actual behaviour in fires.

### **5.2 Variations from the tested specimen**

This report details methods of construction, the test conditions and the results obtained when the specific element of construction described here was tested following the procedure outlined in BS 8414-2:2015+A1:2017.

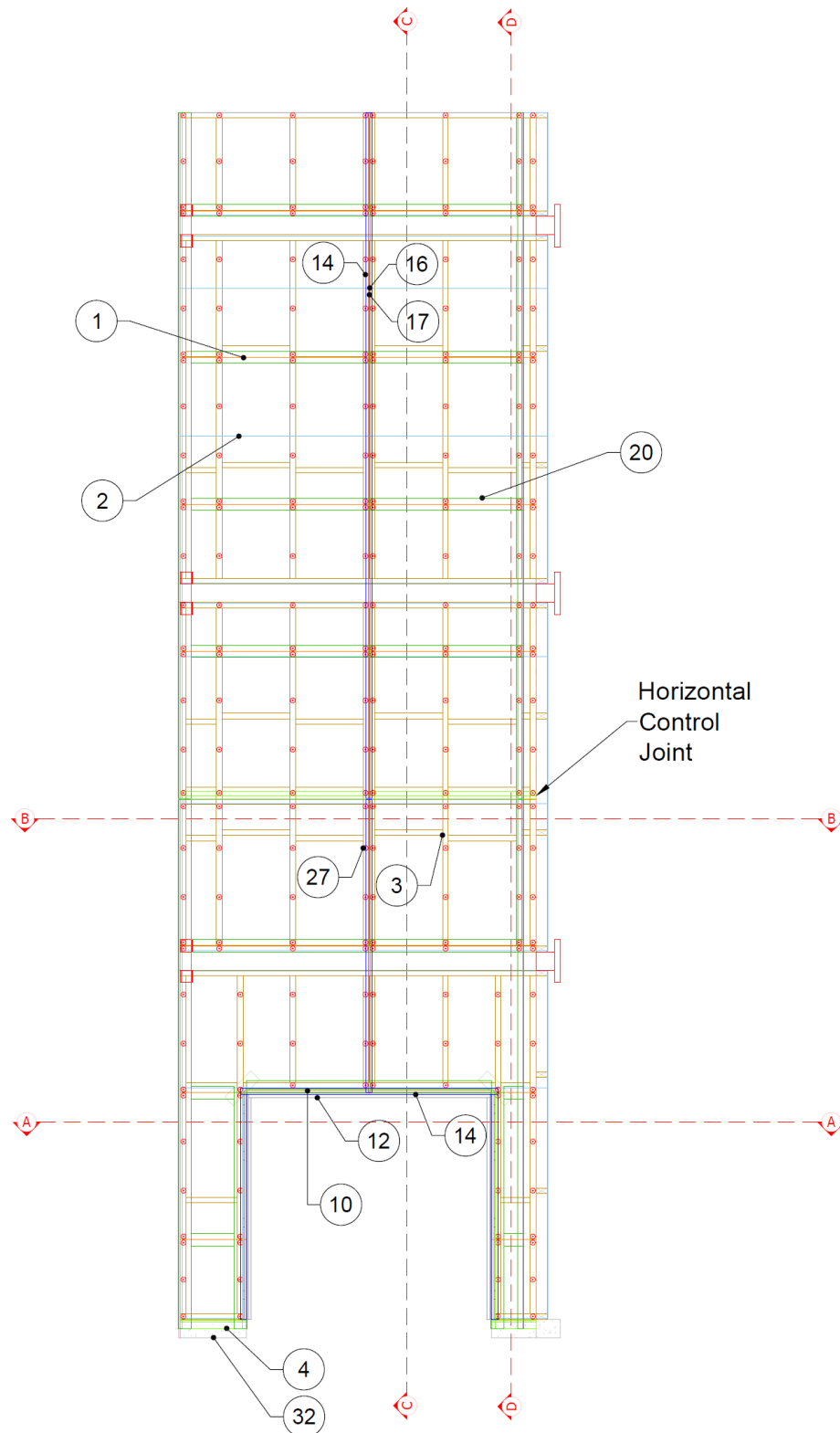
Any significant variation with respect to size, construction details, loads, stresses, edge or end conditions, other than that allowed under the field of direct application in the relevant test method, is not covered by this report.

### **5.3 Uncertainty of measurements**

Because of the nature of reaction-to-fire testing and the consequent difficulty in quantifying the uncertainty of measurements obtained from a reaction-to-fire test, it is not possible to provide a stated degree of accuracy of result.

## Appendix A Drawings of test assembly\*

\*Drawings were provided by Warringtonfire and measurements are in mm



**Figure 1** Panel layout (elevation and section – main wall)

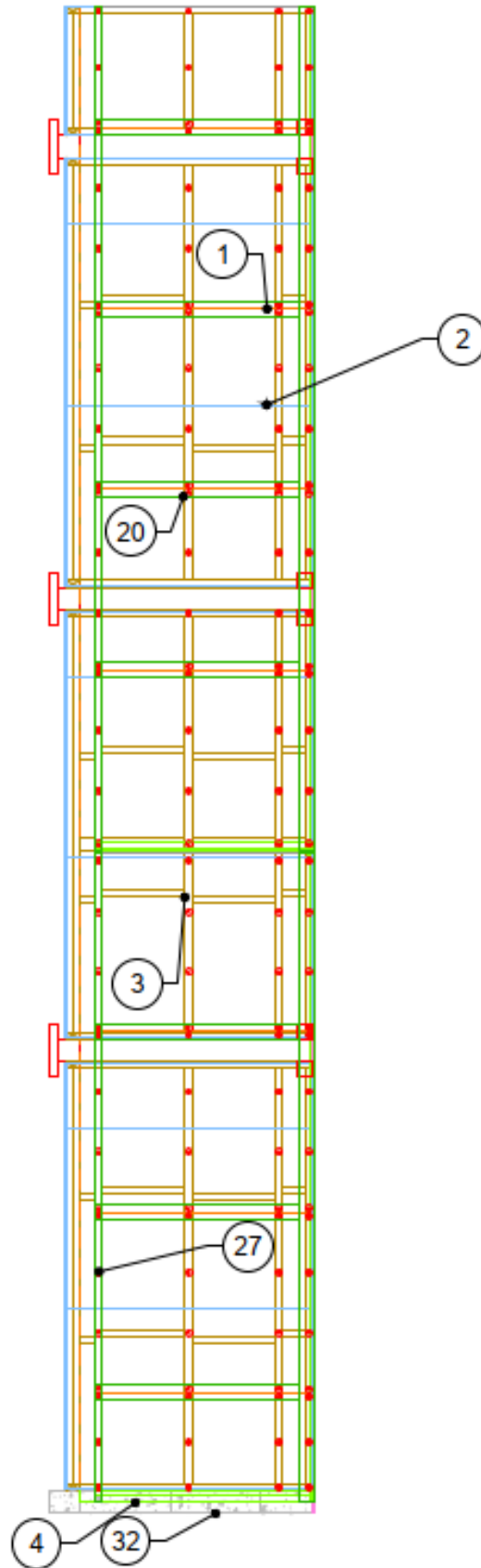
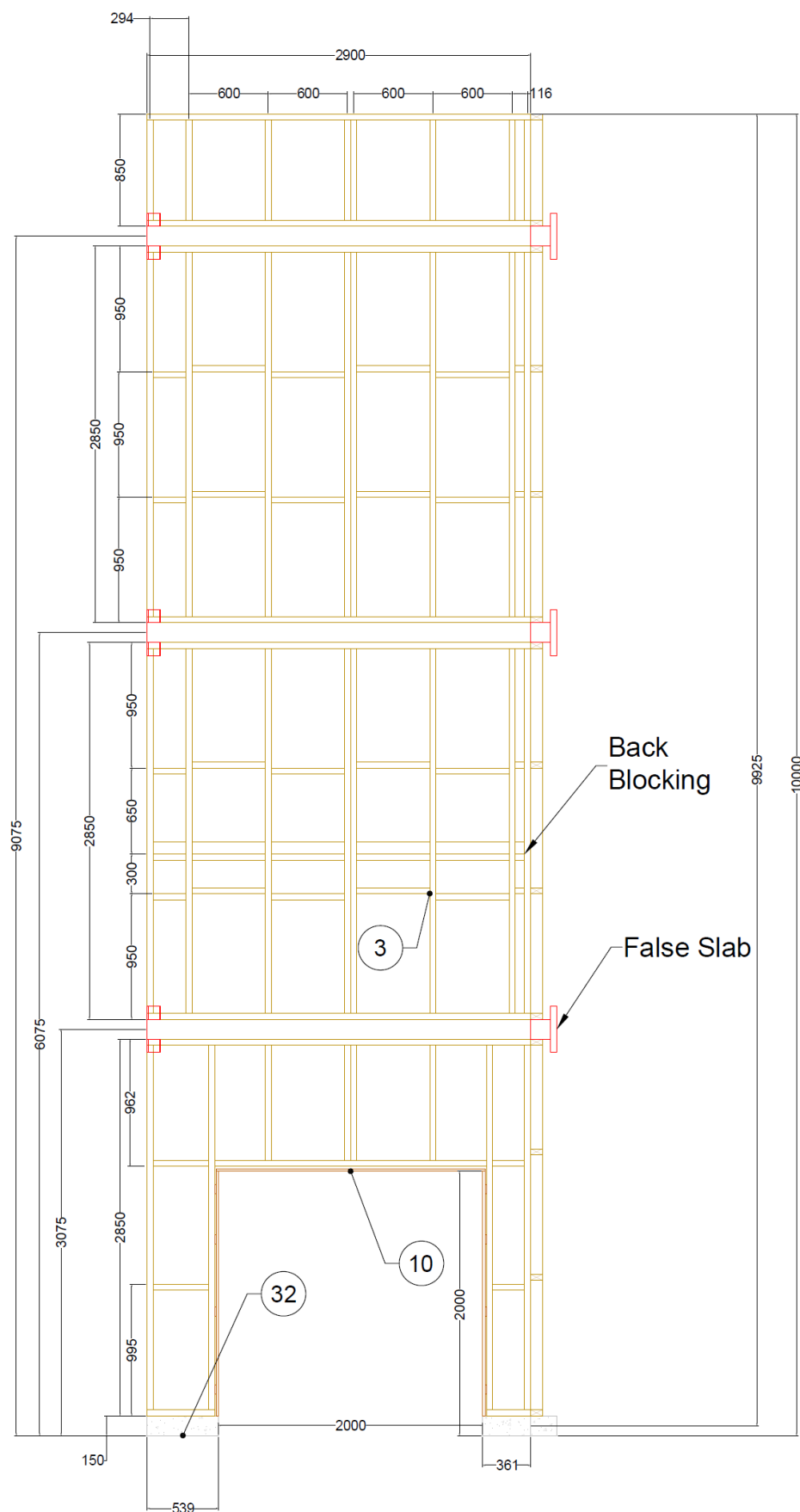


Figure 2 Panel layout (elevation – wing wall)



**Figure 3 Framing layout (elevation – main wall)**

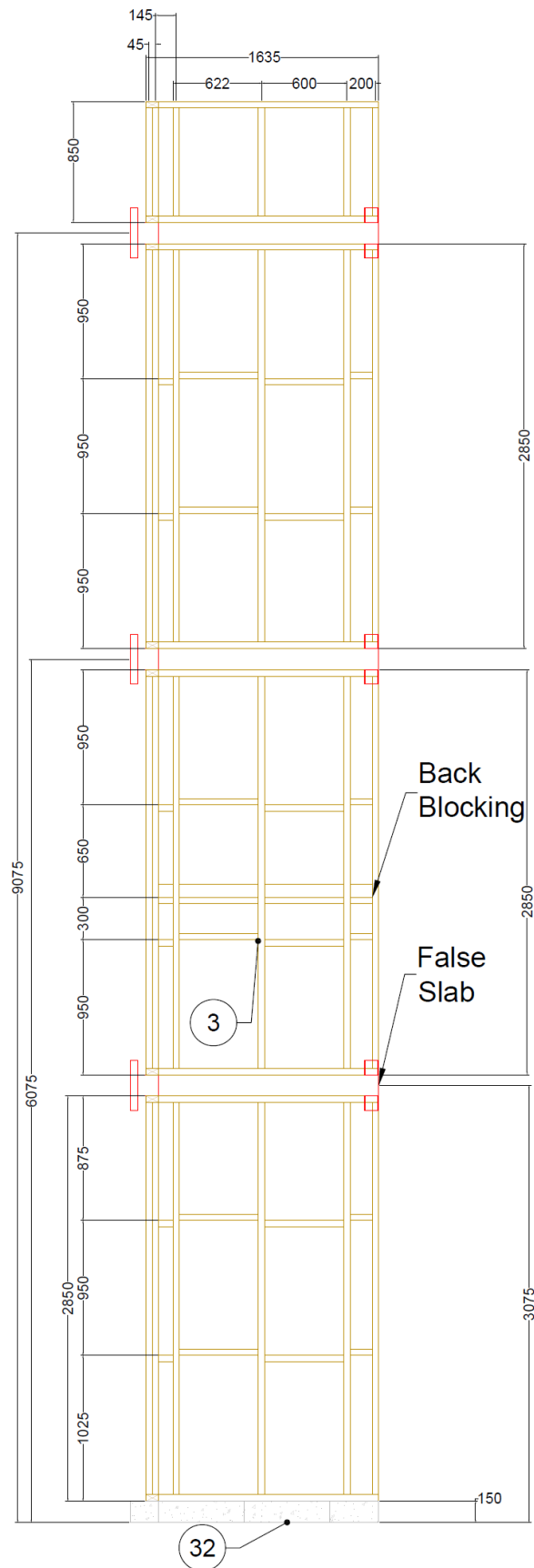


Figure 4 Framing layout (elevation – wing wall)

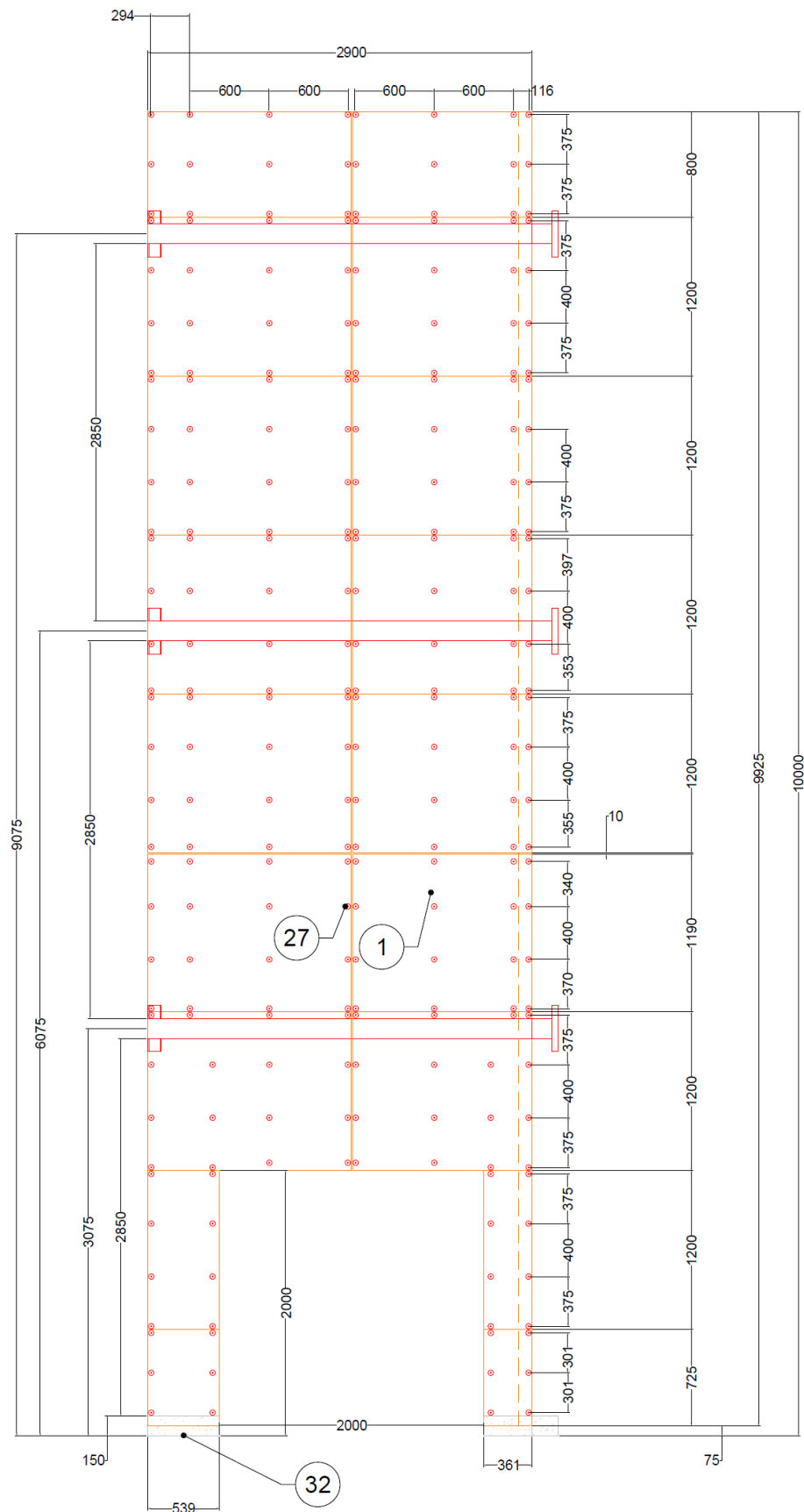


Figure 5 Panel and fixing layout (elevation – main wall)

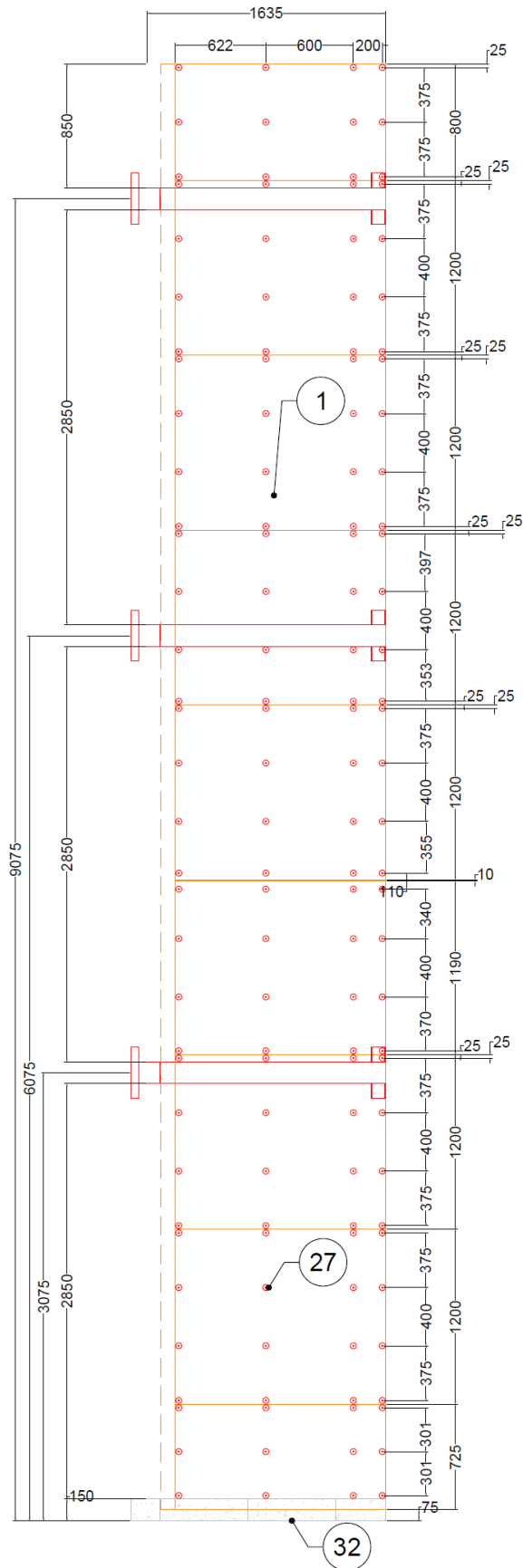


Figure 6 Panel and fixing layout (elevation – wing wall)

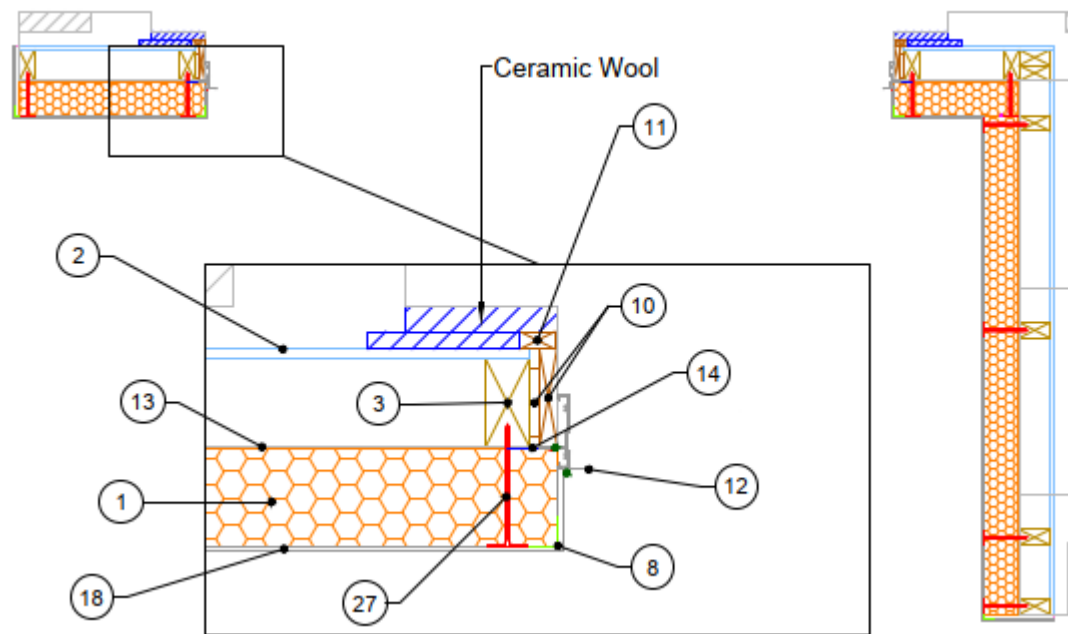


Figure 7 Cross-section A-A

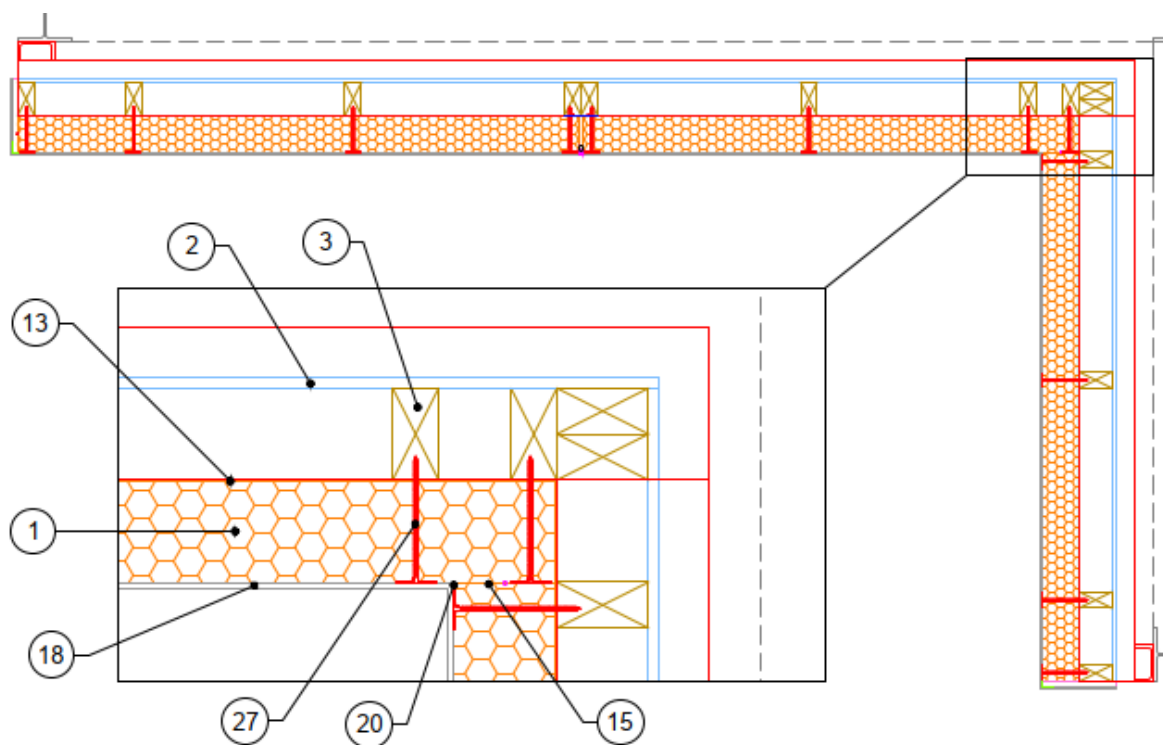


Figure 8 Cross-section B-B

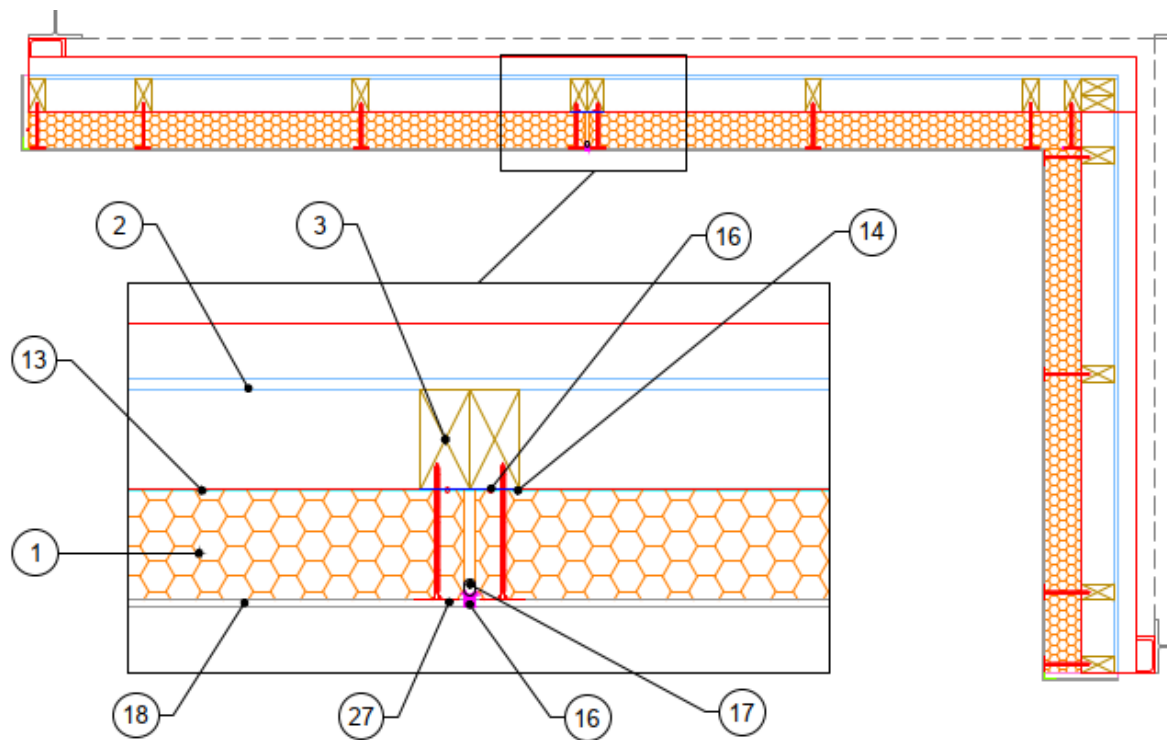


Figure 9 Cross-section B-B (Vertical construction control joint detail)

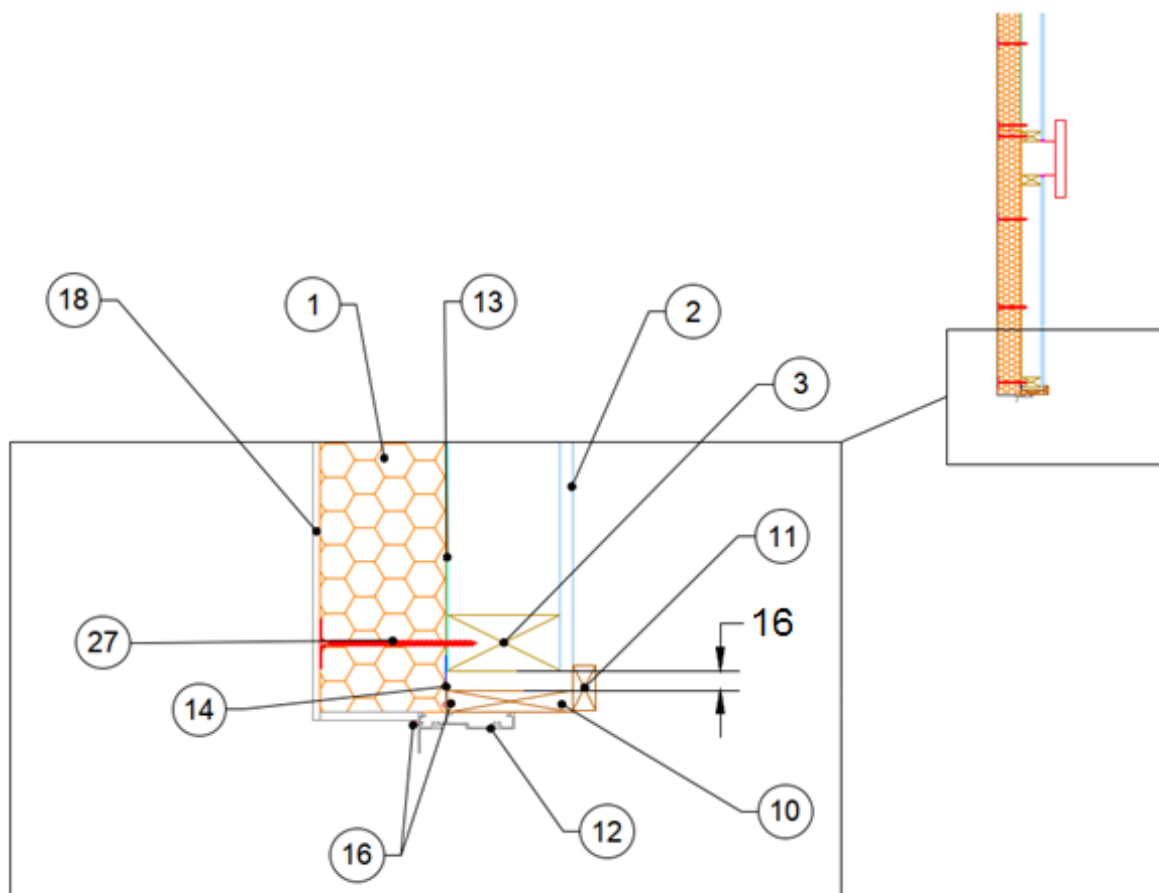


Figure 10 Cross-section C-C (Combustion chamber opening)

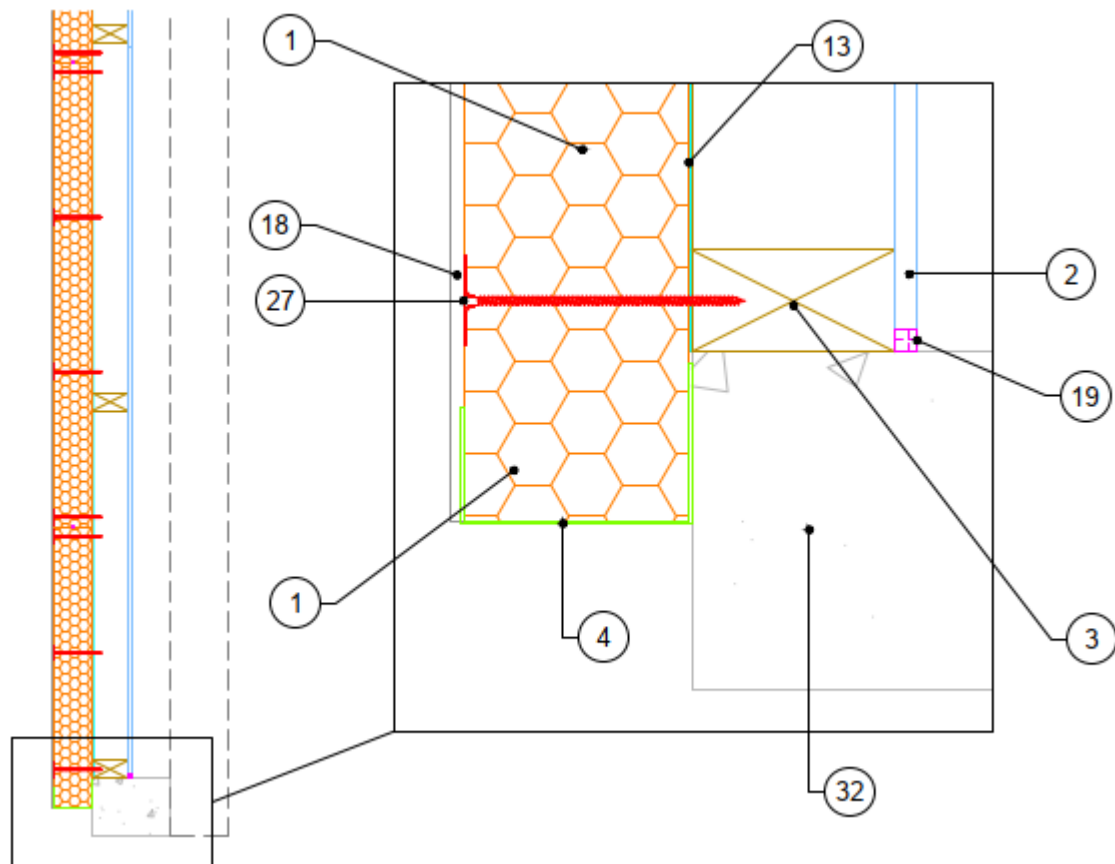


Figure 11 Cross-section D-D (Sill detail)

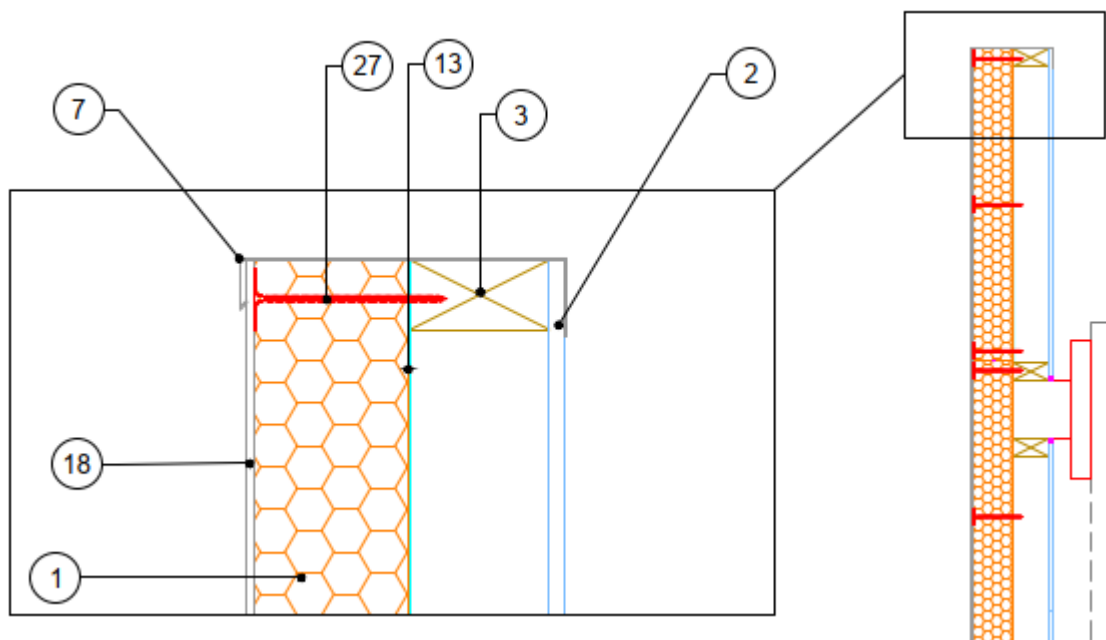


Figure 12 Cross-section D-D (Head of specimen detail)

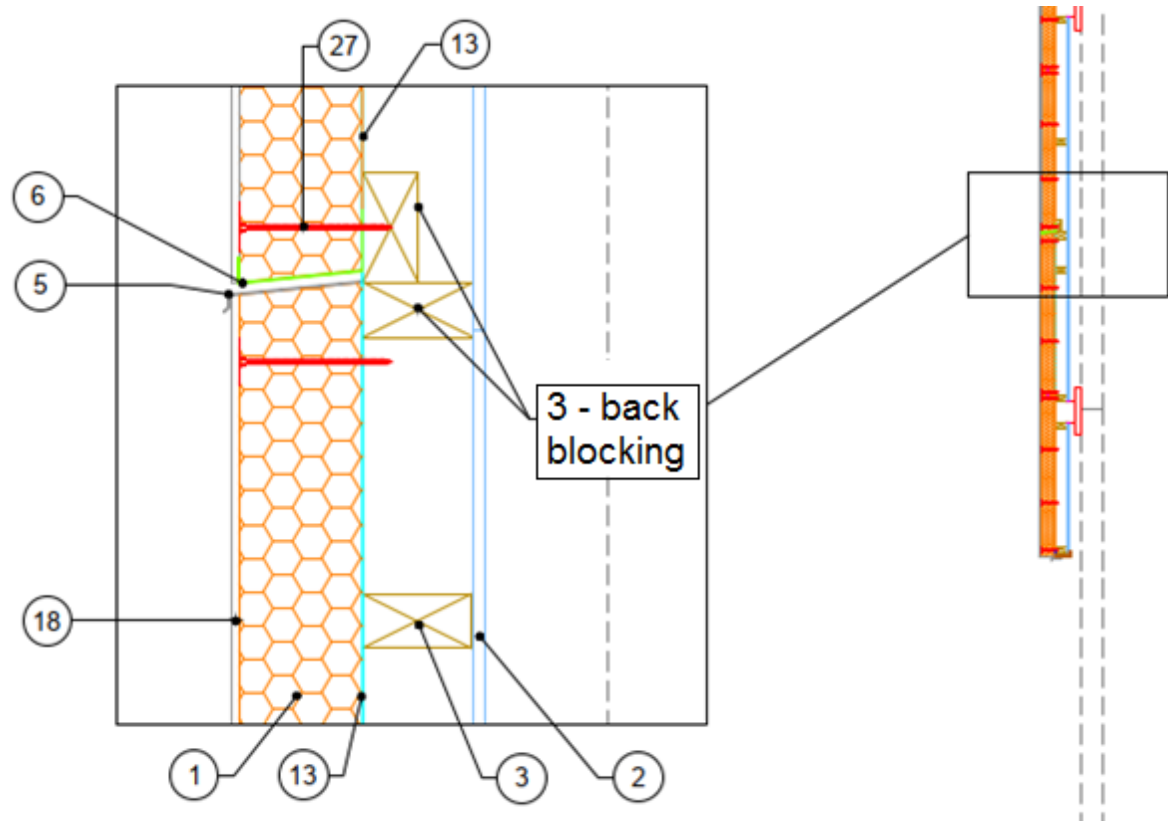


Figure 13 Cross-section C-C (Control joint detail)

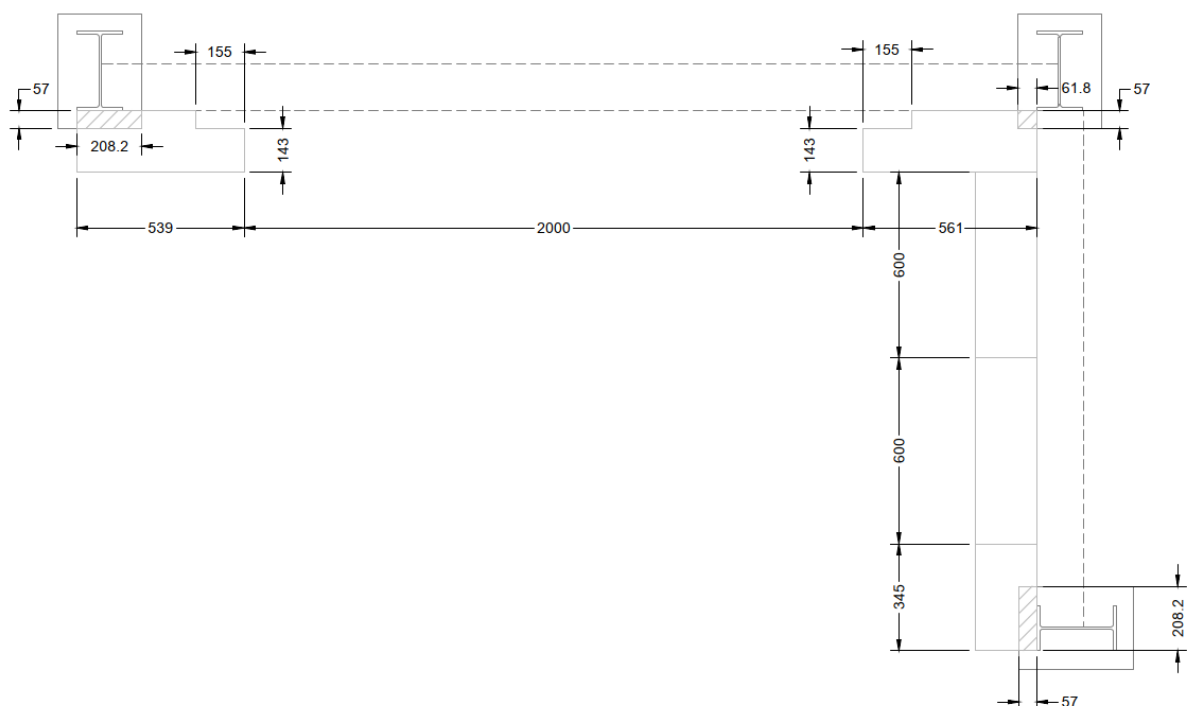


Figure 14 Hebel block layout (from above)

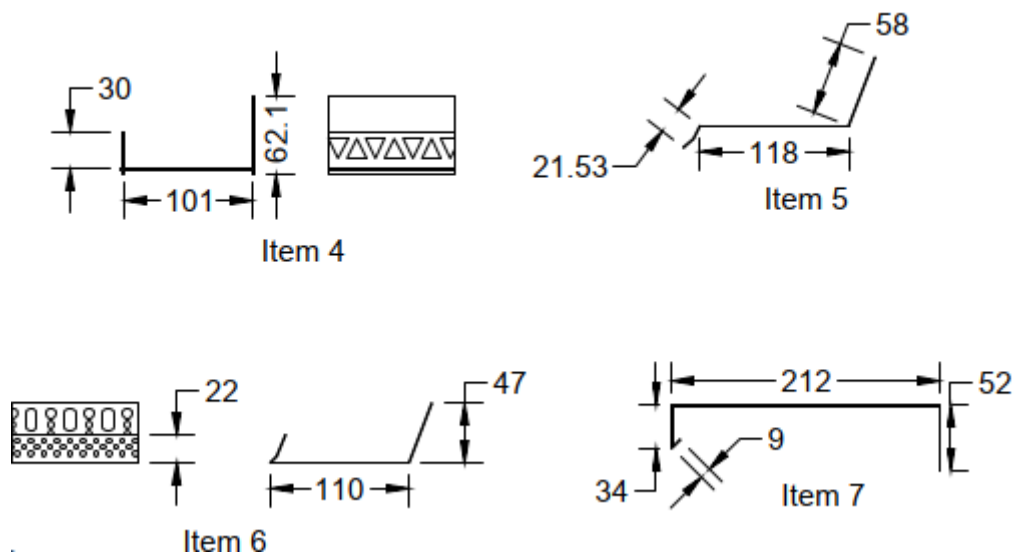


Figure 15 Drawings of flashing components

## Appendix B Test observations

### B.1 Visual observation

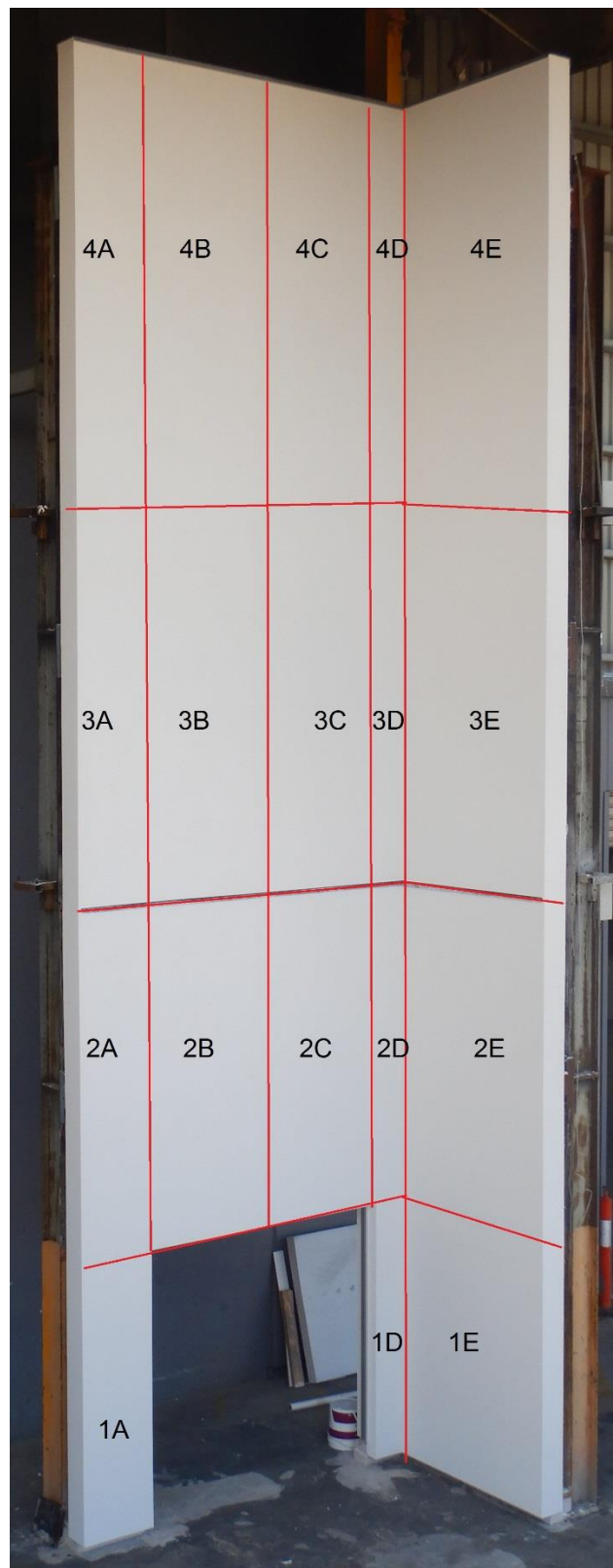


Figure 16 Area designation for observations.

Figure 16 shows the area designation for the observations. Table 9 shows the observations of any significant behaviour of the specimen during the test.

**Table 9 Test observations**

| Time |     | Observation                                                                                                                                                                                                                |
|------|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Min  | Sec |                                                                                                                                                                                                                            |
| 00   | 00  | Crib lit. Reaction-to-fire test started.                                                                                                                                                                                   |
| 03   | 31  | Flames reached the top of the combustion chamber.                                                                                                                                                                          |
| 03   | 50  | Flames exited the combustion chamber.                                                                                                                                                                                      |
| 04   | 10  | The join between 2B and 2C discoloured.                                                                                                                                                                                    |
| 04   | 27  | Flames reached level 1.                                                                                                                                                                                                    |
| 04   | 40  | The join between 2B and 2C, at the top, discoloured.                                                                                                                                                                       |
| 05   | 00  | There was discolouration to the render of 2B and 2C.                                                                                                                                                                       |
| 05   | 15  | The surface of 2C started to flame.                                                                                                                                                                                        |
| 05   | 33  | The joint between 2B and 2C started to flame.                                                                                                                                                                              |
| 05   | 50  | There was independent flaming of the EPS from area 2B and 2C.                                                                                                                                                              |
| 06   | 05  | The surface of 2B started to flame.                                                                                                                                                                                        |
| 06   | 10  | Pieces of render fell from the main wall.                                                                                                                                                                                  |
| 06   | 17  | The joint between 2B and 2C flaming began to spread upward.                                                                                                                                                                |
| 06   | 34  | The starter channel of the horizontal joint in the middle of the main wall started to melt and deform.                                                                                                                     |
| 06   | 36  | There was light discolouration to the wing wall of 1E.                                                                                                                                                                     |
| 06   | 41  | A piece of flaming sealant from the joint between 2B and 2C partially dislodged from the joint and hung in front of the combustion chamber.                                                                                |
| 06   | 47  | Part of the flaming hanging sealant fell to the ground and started a period whereby there was flaming debris on the ground for more than 20 seconds. There was flaming debris on the ground for the remainder of the test. |
| 06   | 59  | The remainder of the flaming hanging sealant fell to the ground.                                                                                                                                                           |
| 07   | 10  | Molten EPS was falling from the specimen.                                                                                                                                                                                  |
| 07   | 30  | There was surface flaming of the render of 3B and 3C.                                                                                                                                                                      |
| 07   | 46  | There was internal EPS flaming from areas 2B and 2C.                                                                                                                                                                       |
| 08   | 05  | The sealant between 3B and 3C began flaming.                                                                                                                                                                               |
| 08   | 26  | The surface flaming of the render of 3B and 3C spread further.                                                                                                                                                             |
| 08   | 30  | There was flaming debris (molten EPS) pooling in front of the specimen.                                                                                                                                                    |
| 09   | 02  | There surface of the wing wall at 2E ignited.                                                                                                                                                                              |
| 09   | 04  | Flames spread to level 2.                                                                                                                                                                                                  |
| 09   | 14  | The lower part of the joint between 4B and 4C was flaming.                                                                                                                                                                 |
| 09   | 35  | The render of 2B and 2C was peeling off the specimen.                                                                                                                                                                      |
| 09   | 50  | More render fell from the specimen.                                                                                                                                                                                        |
| 09   | 50  | There was flame spread along the surface of 3E and 4E.                                                                                                                                                                     |
| 10   | 05  | Flames were constantly reaching the top of the specimen.                                                                                                                                                                   |
| 10   | 17  | The specimen in the corner at the top was flaming. There was flame spread beyond the minimum confines of the specimen, i.e. to the top of the specimen.                                                                    |
| 10   | 30  | There was surface flaming of the render of 4C.                                                                                                                                                                             |

| Time |     | Observation                                                                                                                   |
|------|-----|-------------------------------------------------------------------------------------------------------------------------------|
| Min  | Sec |                                                                                                                               |
| 10   | 45  | There was flaming on the surface of 2A.                                                                                       |
| 11   | 17  | There was a hole in the render of 1E.                                                                                         |
| 11   | 23  | There was debris from the specimen falling to the ground.                                                                     |
| 11   | 25  | Render from the main wall from 2B and 2C had fallen and the EPS had melted/burned away leaving the back plasterboard exposed. |
| 11   | 30  | Flames on the surface of the wing wall had spread beyond 1.2 m horizontally.                                                  |
| 11   | 41  | The surface at the bottom of 1A started to flame.                                                                             |
| 11   | 52  | There was flame spread along the surface of 1A and 2A.                                                                        |
| 12   | 00  | The debris was removed from the test area.                                                                                    |
| 12   | 12  | The specimen and the crib were doused with water. Test was ended.                                                             |

## B.2 Post-test observations

### External wall system

The damaged area of the cladding system is described as follows;

- Approximately 13.0 m<sup>2</sup> of the render had detached.
- Approximately 16.2 m<sup>2</sup> of the render was attached but was heavily damaged by heat.
- Approximately 4.6 m<sup>2</sup> of the render was attached but was moderately damaged by heat.
- Approximately 33.8 m<sup>2</sup> of the EPS panels had melted or burned away.
- Approximately 4.1 m<sup>2</sup> of the EPS panels were slightly melted or heat damaged.
- Approximately 34.5 m<sup>2</sup> of the sarking had melted or burned away.
- Approximately 1.0 m<sup>2</sup> of the timber framing had charred.
- Approximately 2.8 m<sup>2</sup> of the plasterboard paper had heavily charred.
- Approximately 13.8 m<sup>2</sup> of the plasterboard paper had moderately charred.

See Figure 53 to Figure 56 for more details

The amount of fallen debris can only be measured after the test, once it is safe to do so. The approximate mass of collected debris that fell in front of the specimen was 12.96 kg. The debris was collected on a fire protected board, 2.4 m × 1.2 m, laid in front of the test specimen. The board was removed just prior to the extinguishment of the crib and façade and therefore did not contain debris dislodged during the extinguishment process. The mass measurement does not take into account the mass of the EPS that fell during the test and burnt away before the end of the test. Therefore, the mass measurements should be considered as the minimum mass of fallen debris.

- Approximate total mass of debris below 100 g was 11.57 kg.
- Approximate total mass of debris and number of fragments between 100 g and 200 g was 1 and 130 g, respectively.
- There were no fragments between 200 g and 500 g.

The individual mass of each fragment with a mass greater than 500 g are is listed in Table 10 below:

**Table 10 Fragments with a mass greater than 500 g**

| No                                                                                                                                                                                                                                                                                                                                                                 | Mass (kg) |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| 1                                                                                                                                                                                                                                                                                                                                                                  | 1.26      |
| The 1.26 kg piece was mainly composed of once molten EPS that had pooled and solidified. It is unlikely that the piece of debris was due to a singular 1.26 kg piece having fell. This piece of debris represented most of the remaining EPS. The other measured debris was mainly composed of other components of the specimen such as render and some aluminium. |           |

## Appendix C Instrumentation locations

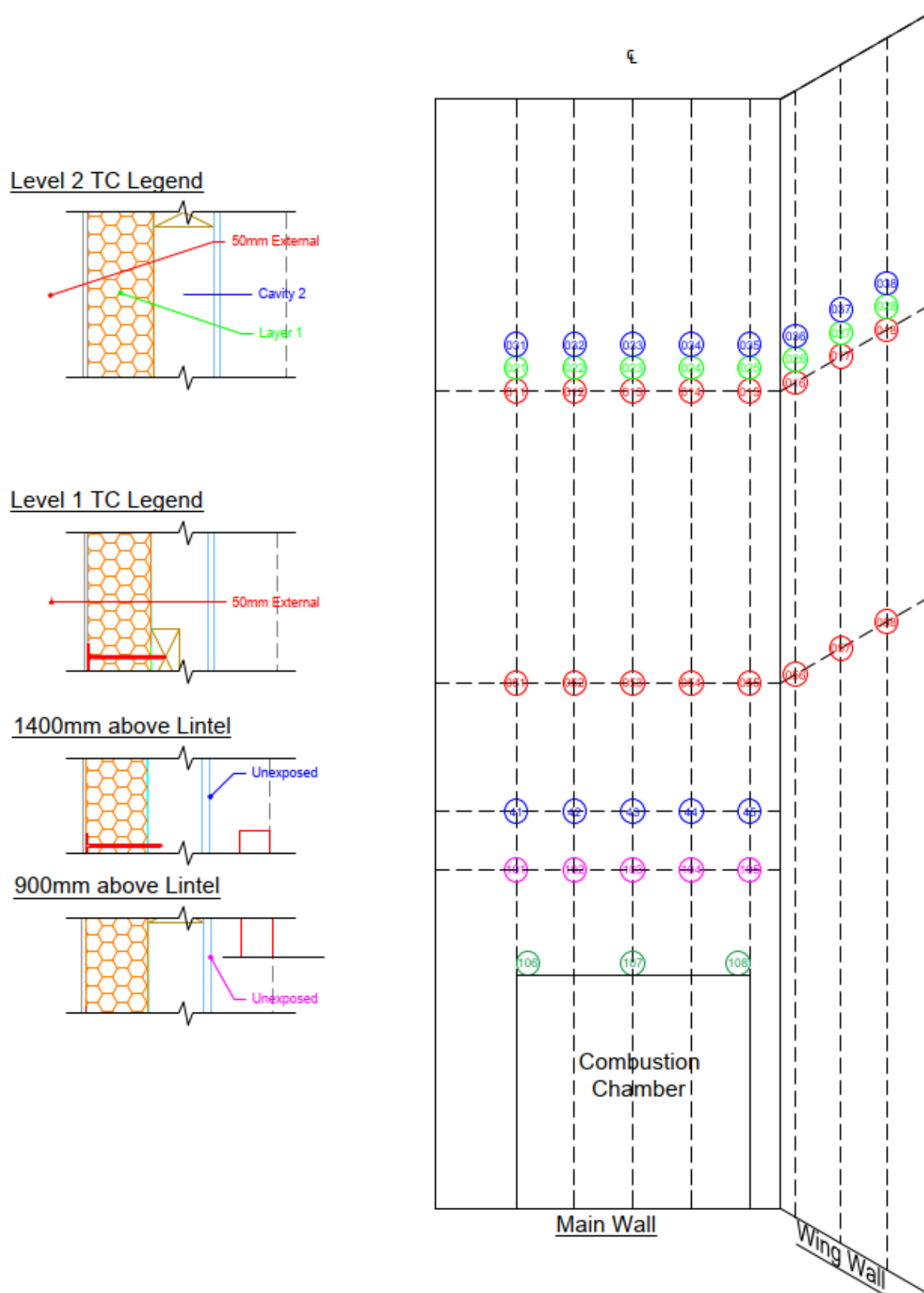


Figure 17 Thermocouple locations

## Appendix D Test data

### D.1 Specimen temperatures

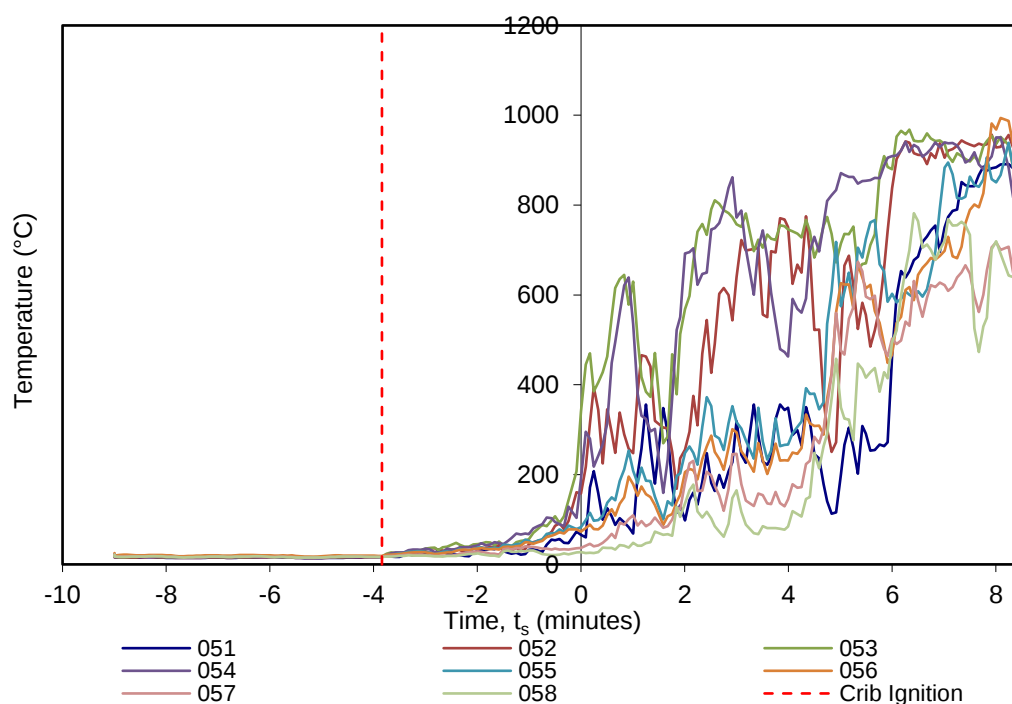


Figure 18 Level 1, external – temperature vs time

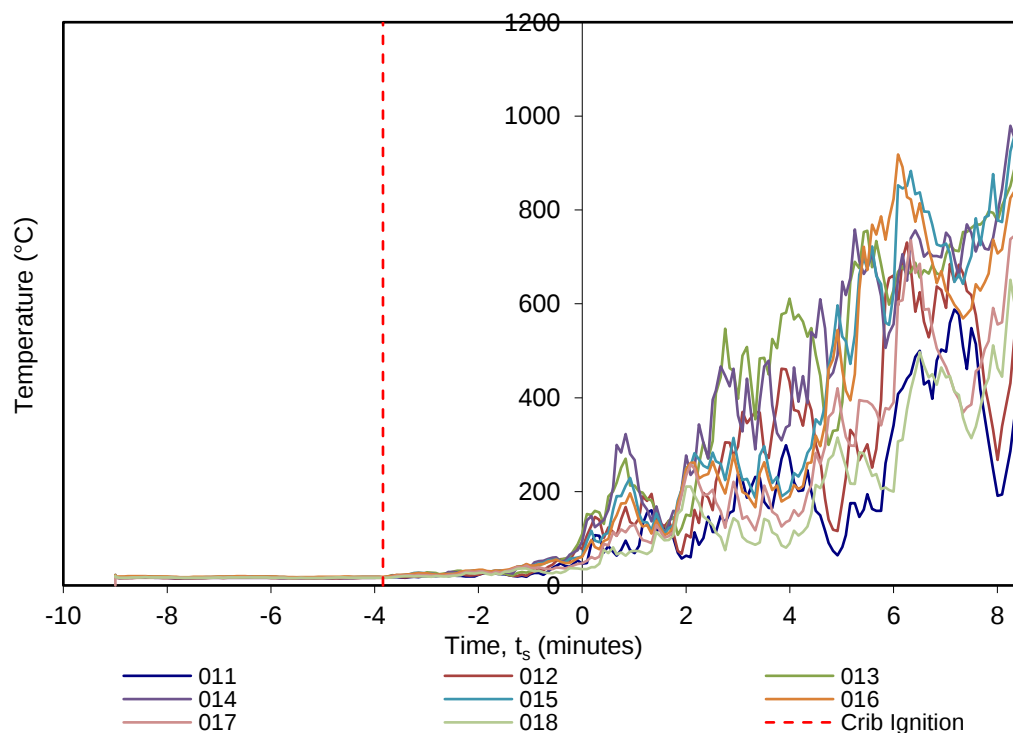


Figure 19 Level 2, external – temperature vs time

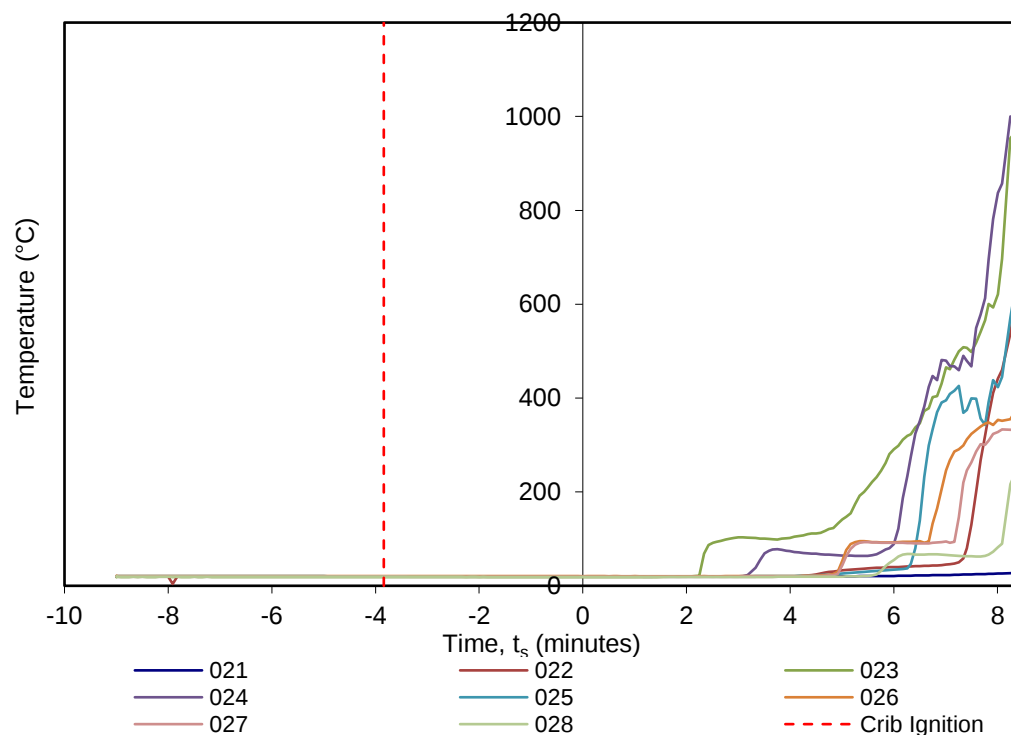


Figure 20 Level 2, panel layer – temperature vs time

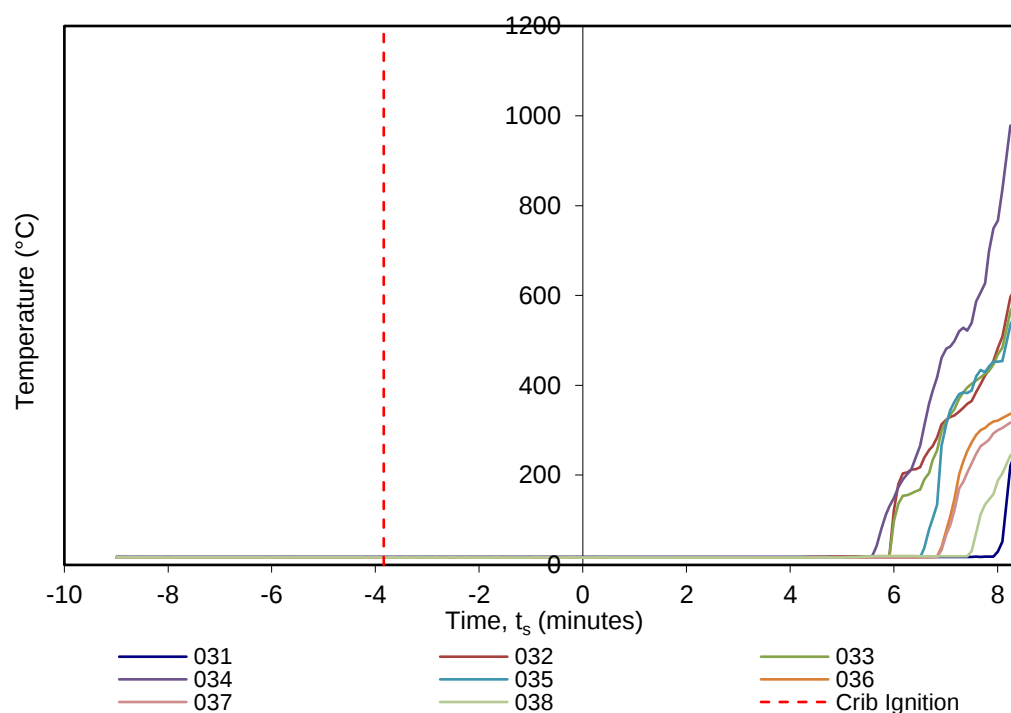


Figure 21 Level 2, frame cavity – temperature vs time

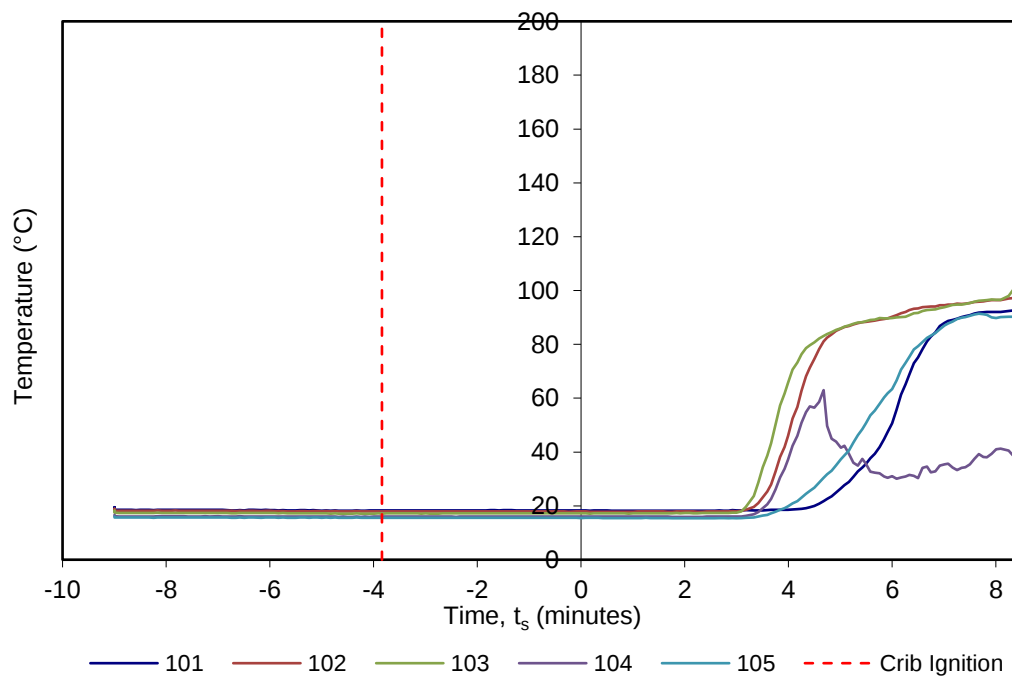


Figure 22 900mm above chamber opening – temperature vs time

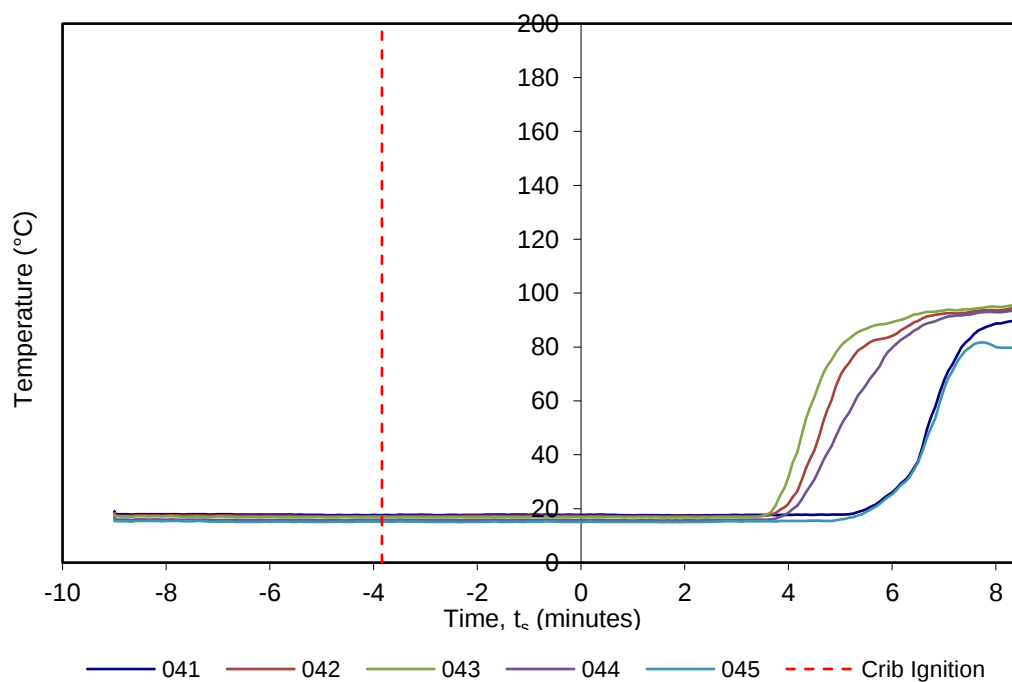


Figure 23 1400mm above chamber opening – temperature vs time

## Appendix E Photographs



Figure 24 The timber framing during construction – back blocking not present at this stage.



Figure 25 The time framing with plasterboard cladding.



Figure 26 The wall system with EPS panels during rendering.



Figure 27 The wall system with rendered (1<sup>st</sup> render coat) EPS panels during construction.



Figure 28 The complete external cladding system before the start of the test – main wall



**Figure 29** The complete external cladding system before the start of the test – wing wall



**Figure 30** The unexposed side of the external wall system before the start of the test – main wall



**Figure 31** The unexposed side of the external wall system before the start of the test – wing wall



Figure 32 The external wall system during the test – 49 seconds after crib ignition



Figure 33 The external wall system during the test – 1 minute 50 seconds after crib ignition



Figure 34 The external wall system during the test – 5 minutes 50 seconds after crib ignition



Figure 35 The external wall system during the test – 6 minutes 50 seconds after crib ignition



Figure 36 The external wall system during the test – 7 minutes 50 seconds after crib ignition



Figure 37 The external wall system during the test – 8 minutes 50 seconds after crib ignition



Figure 38 The external wall system during the test – 9 minutes 50 seconds after crib ignition



Figure 39 The external wall system during the test – 10 minutes 50 seconds after crib ignition



**Figure 40** The external wall system at the end of the test.



Figure 41 The external wall system on completion of the test – main wall



Figure 42 The external wall system on completion of the test – wing wall



**Figure 43** The unexposed side of the external wall system on completion of the test – main wall



Figure 44 The unexposed side of the external wall system on completion of the test – wing wall



**Figure 45** The post-test external wall system with the severely heat damaged render removed – main wall



Figure 46 The post-test external wall system with severely heat damaged render removed – wing wall



Figure 47 The post-test external wall system with all render removed – main wall



**Figure 48** The post-test external wall system with all render removed – wing wall



**Figure 49** The post-test external wall system with all EPS panels removed – main wall.

N.B. Image has been doctored to remove the branding from the sarking.



**Figure 50** The post-test external wall system with all EPS panels removed – wing wall  
N.B. Image has been doctored to remove the branding from the sarking.



**Figure 51** The post-test external wall system with the sarking removed – main wall



**Figure 52** The post-test external wall system with the sarking removed – wing wall

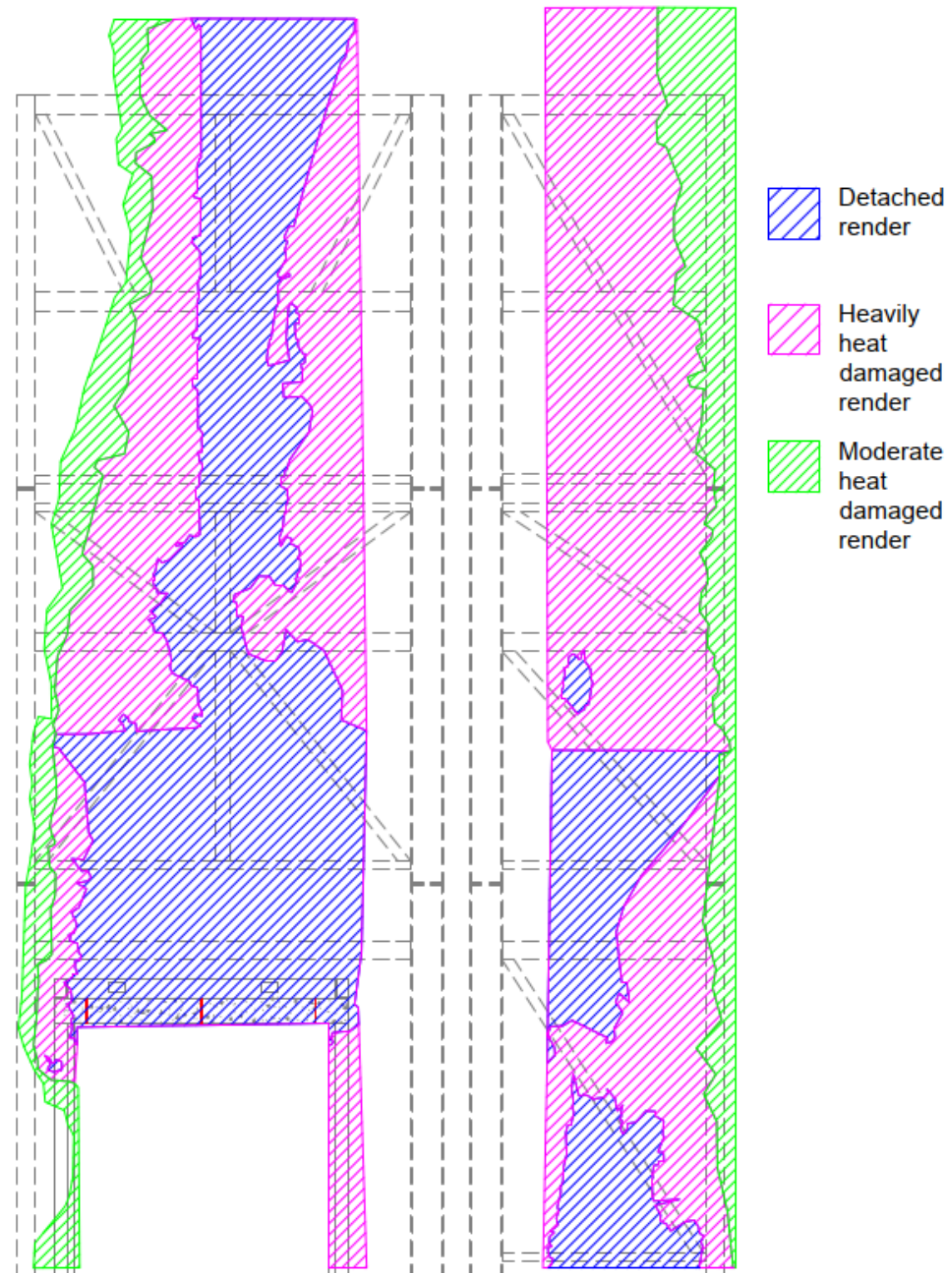


Figure 53 Drawing of the condition of the cladding – render

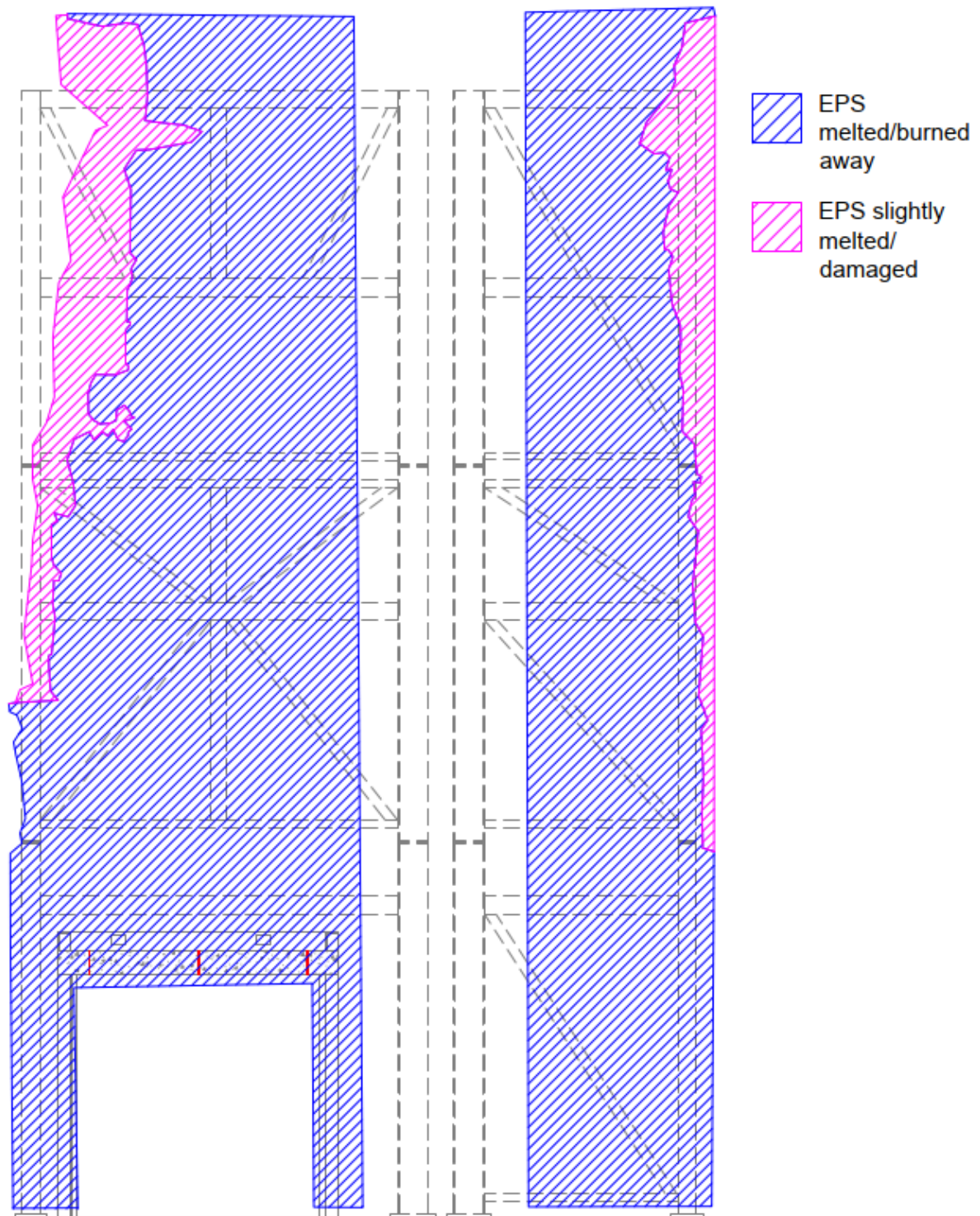


Figure 54 Drawing of the condition of the cladding – EPS panels

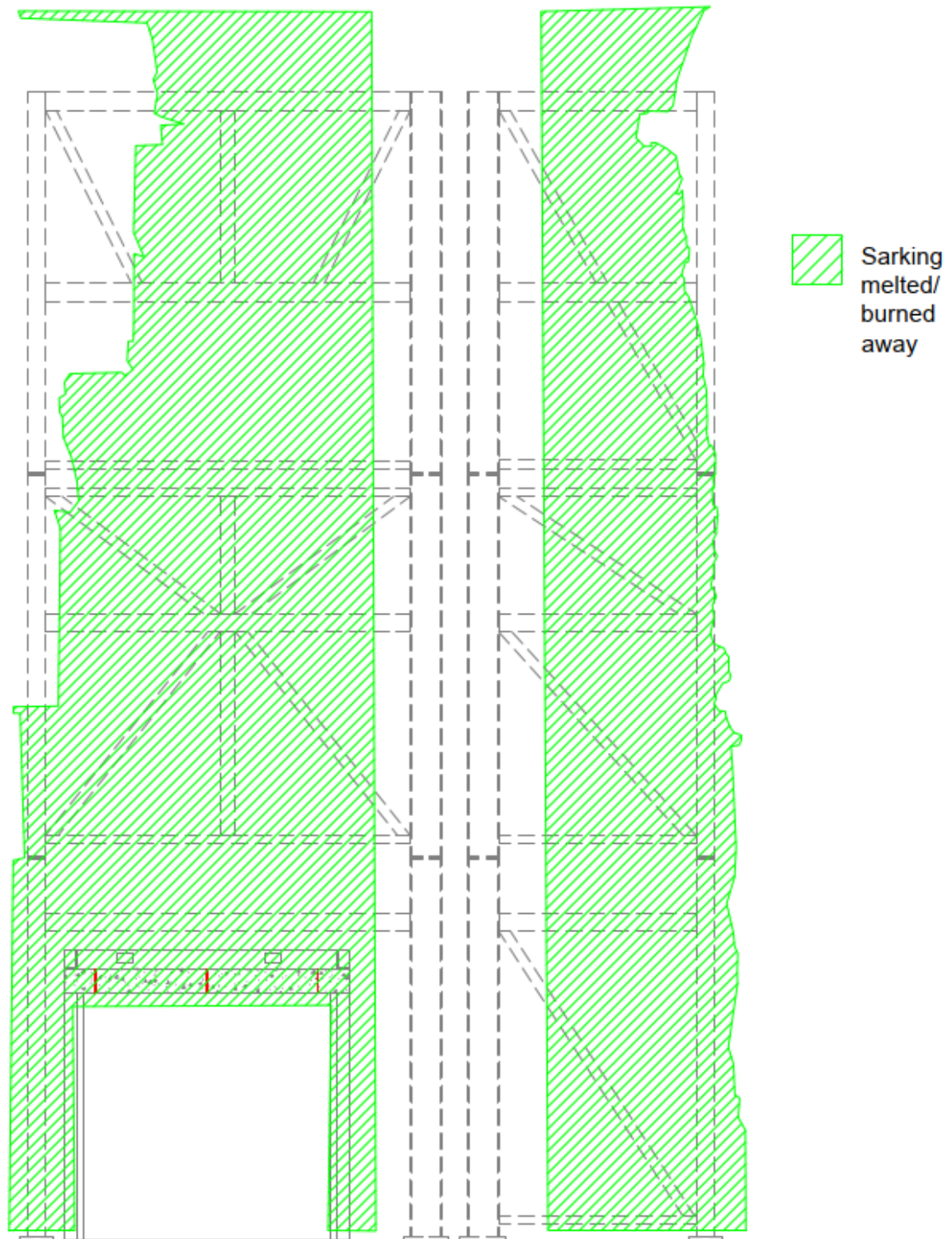


Figure 55 Drawing of the condition of the cladding – sarking

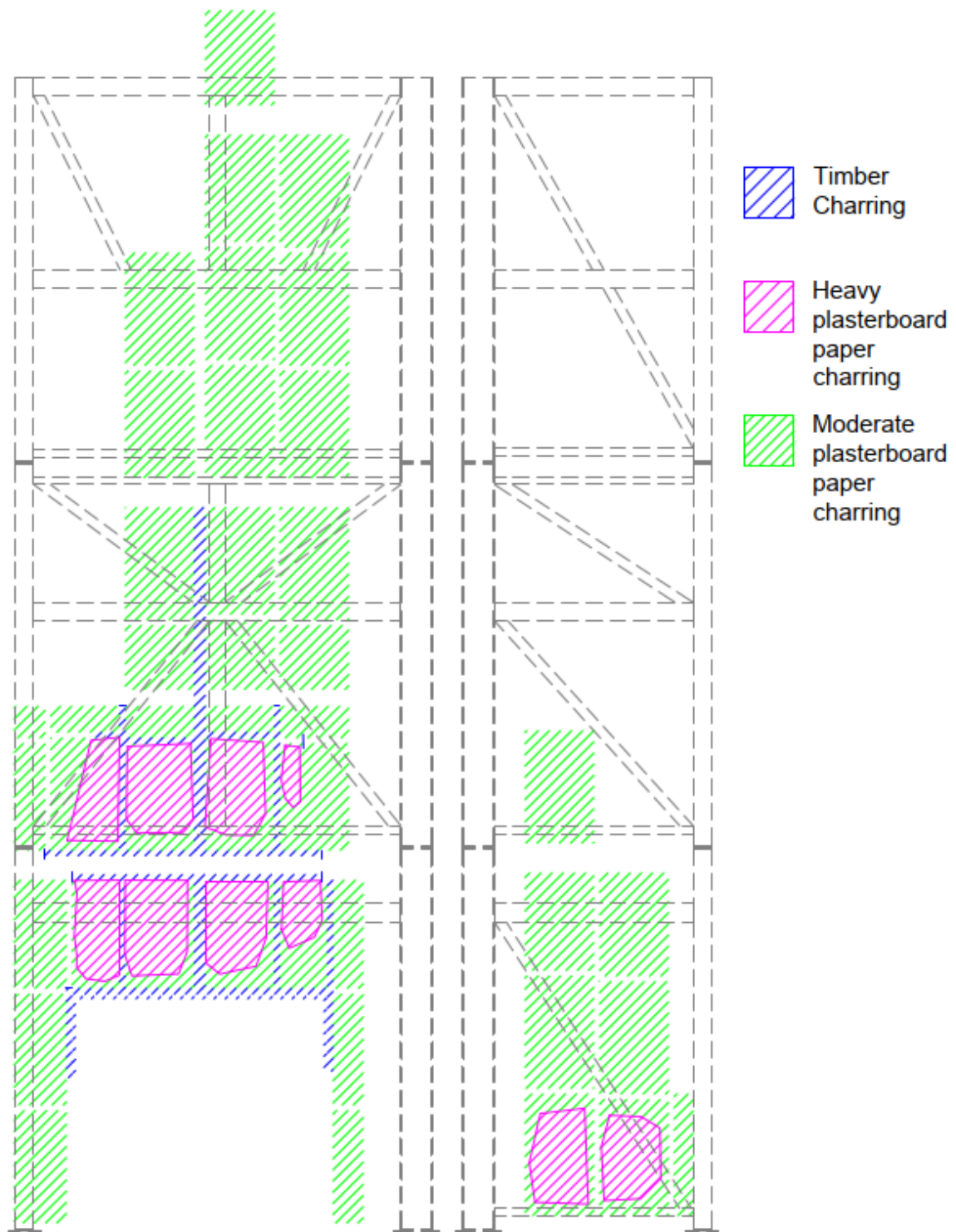


Figure 56 Drawing of the condition of the cladding – timber framing and plasterboard