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Technical Report

PROTECTED STRUCTURAL STEEL ELEMENTS – BEST PRACTICE GUIDE

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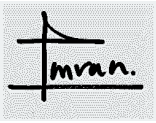
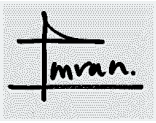
	Expiry date	30 April 2030			

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1 Executive Summary

PERLIFOC HP Eco+ and PYROCRETE 60 sprays are non-reactive passive fire protection products used to protect structural steel members. As established in the BRANZ fire assessment report FC15622-01-4, dated 14 February 2024, PERLIFOC HP Eco+ spray has been assessed to provide fire protection to structural steel members for fire resistance periods of up to 240 minutes, in accordance with AS 4100:2020. Similarly, BRANZ fire assessment report FC20361-01-1, dated 9 December 2024, PYROCRETE 60 spray has been assessed to provide fire protection to structural steel members for fire resistance periods of up to 240 minutes, in accordance with AS 4100:2020.

Nullifire SC901/902 intumescent coating is a reactive passive fire protection product used to protect structural steel members. As established in the BRANZ fire assessment report FC18580-01-01, dated 20 March 2024, Nullifire SC901/902 intumescent coating has been assessed to provide fire protection to structural steel members for fire resistance periods of up to 120 minutes, in accordance with AS 4100:2020.

Halliwell Fire Research has prepared this technical report to outline best-practice guidelines for the protection of structural steel members using PERLIFOC HP Eco+, PYROCRETE 60 or Nullifire SC901/902, particularly where these protected steel members interface with other fire-separating elements. These recommendations are intended to ensure that the fire resistance performance of steel members protected with PERLIFOC HP Eco+, PYROCRETE 60 or Nullifire SC901/902 are not compromised.

The report considers the following construction scenarios:

- PERLIFOC HP Eco+, PYROCRETE 60 or Nullifire SC901/902 protected steel column interfacing with masonry wall
- PERLIFOC HP Eco+, PYROCRETE 60 or Nullifire SC901/902 protected steel column interfacing with fire rated board wall systems
- PERLIFOC HP Eco+, PYROCRETE 60 or Nullifire SC901/902 protected steel beam interfacing with composite floor systems

Based on the discussion in Section 4 of this report, the proposed construction details for PERLIFOC HP Eco+, PYROCRETE 60 or Nullifire SC901/902 protected structural steel members – when installed in accordance with the manufacturer's instructions and the guidance provided in the relevant fire assessment reports – are not expected to compromise the fire resistance performance of the system, if tested in accordance with AS 1530.4:2014.

2 Introduction

2.1 General

Tremco CPG Australia Pty Ltd have engaged Halliwell Fire Research to prepare a technical report to outline best-practice guidelines for the protection of structural steel members using PERLIFOC HP Eco+, PYROCRETE 60 or Nullifire SC901/902, particularly where these protected steel members interface with other fire-separating elements.

2.2 The scope of this report

The scope of the technical report is limited to the below:

- This report provides the best-practice guidelines for the protection of structural steel members using PERLIFOC HP Eco+, PYROCRETE 60 or Nullifire SC901/902, particularly where these protected steel members interface with following fire-separating elements:
  - masonry wall
  - fire rated board wall systems
  - composite floor systems
- This report discusses the response of the interface between PERLIFOC HP Eco+, PYROCRETE 60 or Nullifire SC901/902 protected steel elements and some separating elements (as listed above) when exposed to exposed to AS 1530.4:2014 fire conditions. The response of these interfaces to any other fire scenarios is not part of the scope of this report.
- These guidelines are applicable to structural steel members of various shapes and section factors, provided they fall within the allowable limits specified in respective fire assessment reports.

2.3 Limitations and requirements

- This report is only valid for considered construction details and must not be used for any other purpose. Any changes – other than those identified in this report – may invalidate the findings of this report. If there are changes to the system, a reassessment will need to be done.
- The maximum fire resistance performance is governed by the minimum fire resistance rating of PERLIFOC HP Eco+, PYROCRETE 60 or Nullifire SC901/902 protected steel element and the interfacing separating element.
- This report has been prepared based on information provided by the report sponsor including test reports, fire assessment reports and material properties. We have not independently verified the accuracy of this information and therefore cannot be held responsible for any errors or omissions that may be present in this report as a result.
- This report was prepared at the request of Tremco CPG Australia Pty Ltd for their specific purposes. Structural engineers, fire safety engineers, building certifiers, approval authorities, and other third parties are responsible for determining the suitability of using the outcomes of this report for a given construction circumstance.
- The client must withdraw this report from circulation if the component or element of structure is the subject of a fire test by a test authority in accordance with the standard against which this assessment is being made and the results are not in agreement with this report. They must also withdraw this report if they get to know any information that could adversely affect the conclusions of this report.

3 Background Information

3.1 General

This technical report was prepared based on the test evidence listed in Table 1.

Table 1 Test evidence

Report	Issuing authority	Test date
FC15622-01-4	BRANZ	14 February 2024
FC20361-01-1	BRANZ	9 December 2024
FC18580-01-01	BRANZ	20 March 2024

3.2 Evidence

3.2.1 Fire assessment report test FC15622-01-4

The fire assessment report FC15622-01-4, dated 14 February 2024 and issued by BRANZ, outlines the expected fire resistance performance of I and H steel section beams and columns, and hollow section columns protected with PERLIFOC HP Eco+ spray in accordance with AS 4100:2020. The report is based on test evidence from fire tests Tecnalia 069502-001-a, Tecnalia 069502-002-a, Tecnalia 074359-001-a and AFITI LICOF 3407T18.

Using the evidence of these tests, the assessment has been conducted using the assessment methodology of EN 13381-4:2013, which is accepted in accordance with AS 4100:2020. The outcomes of the assessment can be used to determine the required PERLIFOC HP Eco+ spray thickness to achieve a given Period of Structural Adequacy (PSA), provided that the section factor and the critical temperature of the steel member is known. The PSA is defined as the time (in minutes) for the member to reach the limit state of structural adequacy in the standard fire test as per AS 1530.4:2014, and it must be greater than or equal to the required Fire Resistance Level (FRL) stipulated in the National Construction Code (NCC) for a given structural steel member.

3.2.2 Fire assessment report test FC20361-01-1

The fire assessment report FC20361-01-1, dated 9 December 2024 and issued by BRANZ, outlines the expected fire resistance performance of I and H steel section beams and columns protected with PYROCRETE 60 spray in accordance with AS 4100:2020. The report is based on test evidence from fire tests 24/32300331, 24/32300388 and 24/32300391.

Using the evidence of these tests, the assessment has been conducted using the assessment methodology of EN 13381-4:2013, which is accepted in accordance with AS 4100:2020. The outcomes of the assessment can be used to determine the required PYROCRETE 60 spray thickness to achieve a given PSA, provided that the section factor and the critical temperature of the steel member is known.

3.2.3 Fire assessment report test FC18580-01-01

The fire assessment report FC18580-01-01, dated 20 March 2024 and issued by BRANZ, outlines the expected fire resistance performance of I and H steel section beams and columns, and rectangular and circular hollow section columns protected with Nullifire SC901/902 intumescent coating in accordance with AS 4100:2020.

The report is based on test evidence from fire test UL 4787351003. Using the evidence of these tests, the assessment has been conducted using the assessment methodology given AS 4100:2020. The outcomes of the assessment can be used to determine the required Nullifire

SC901/902 thickness to achieve a given PSA, provided that the section factor and the critical temperature of the steel member is known.

4 Technical discussion

4.1 General

This technical report discusses fire performance of varying applications of PERLIFOC HP Eco+, PYROCRETE 60 or Nullifire SC901/902 protected structural steel beams and columns and the best practices to be followed.

Applications considered in this report include:

- PERLIFOC HP Eco+, PYROCRETE 60 or Nullifire SC901/902 protected steel column interfacing with masonry wall (see Figure 1 and Figure 2)
- PERLIFOC HP Eco+, PYROCRETE 60 or Nullifire SC901/902 protected steel column interfacing with fire rated board wall systems (see Figure 3 and Figure 4)
- PERLIFOC HP Eco+, PYROCRETE 60 or Nullifire SC901/902 protected steel beam interfacing with composite floor systems (see Figure 5 to Figure 8)

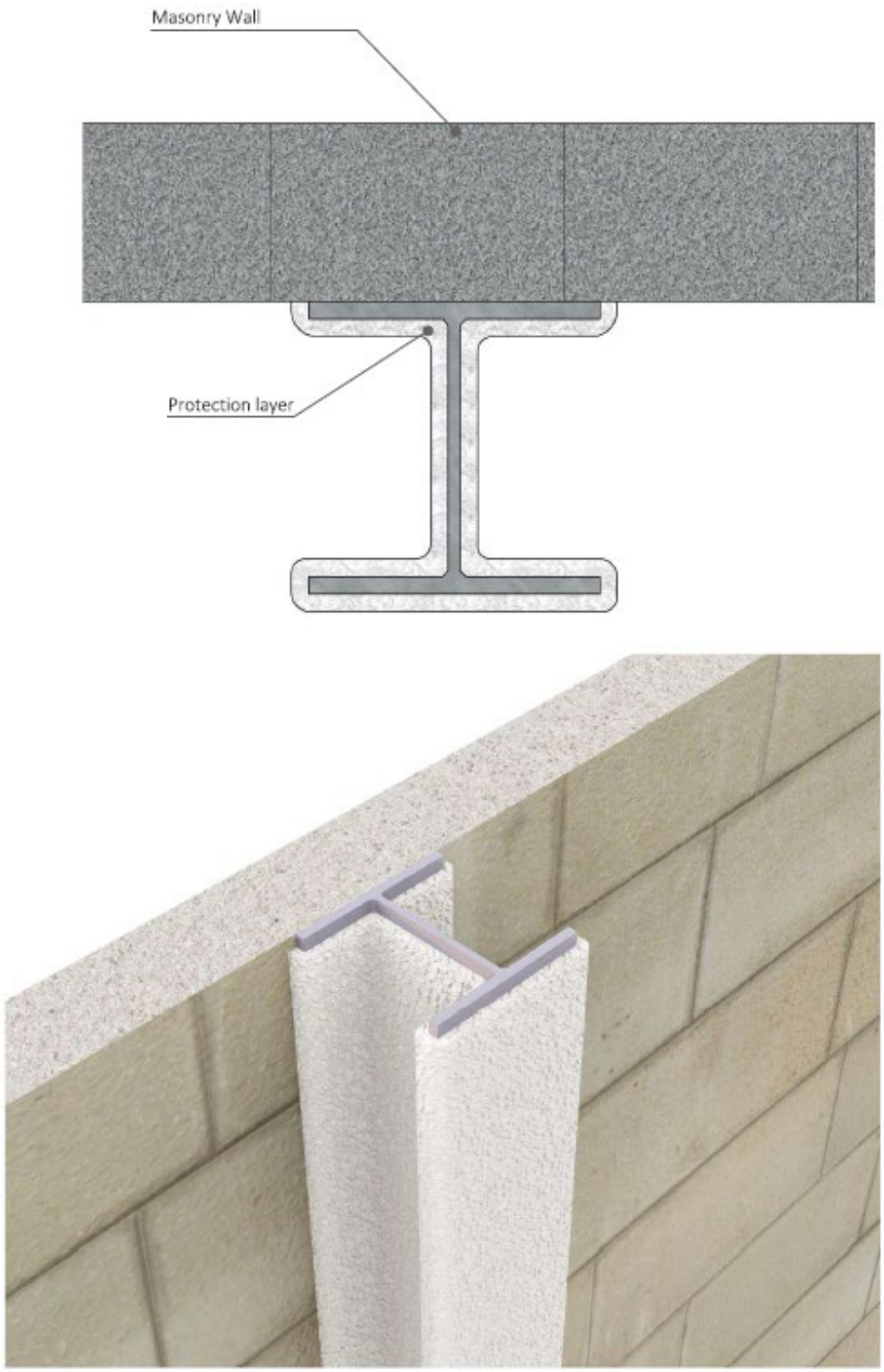
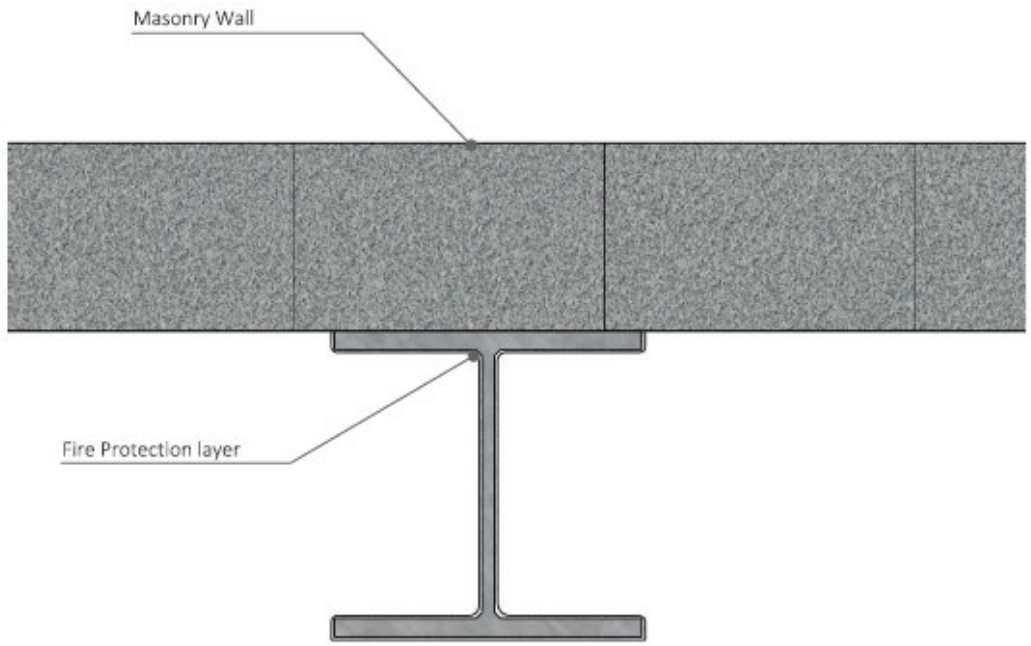


Figure 1 PERLIFOC HP Eco+ or PYROCRETE 60 spray protected steel column interfacing with masonry wall



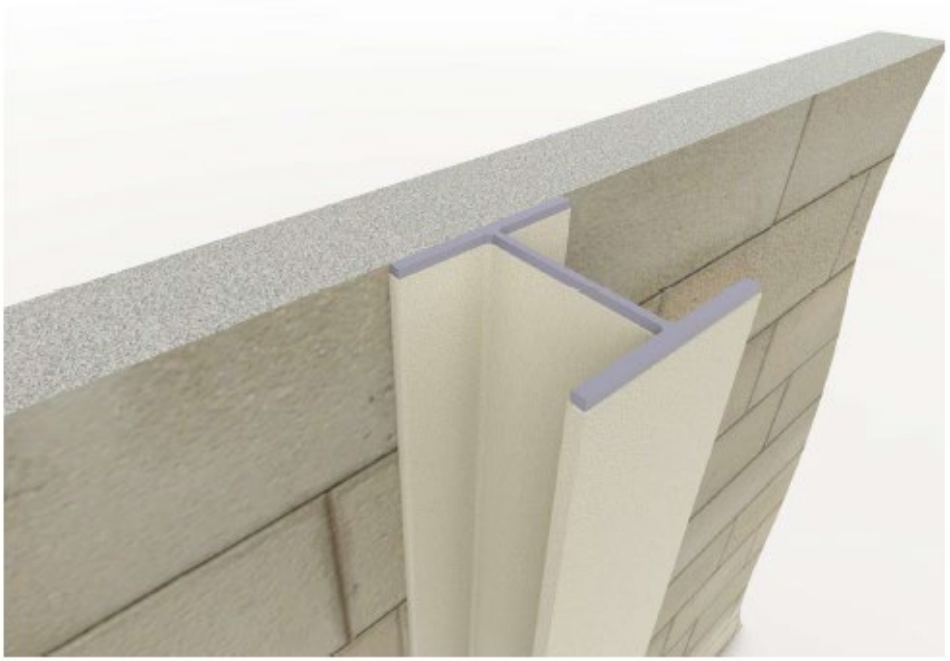


Figure 2 Nullifire SC901/902 protected steel column interfacing with masonry wall

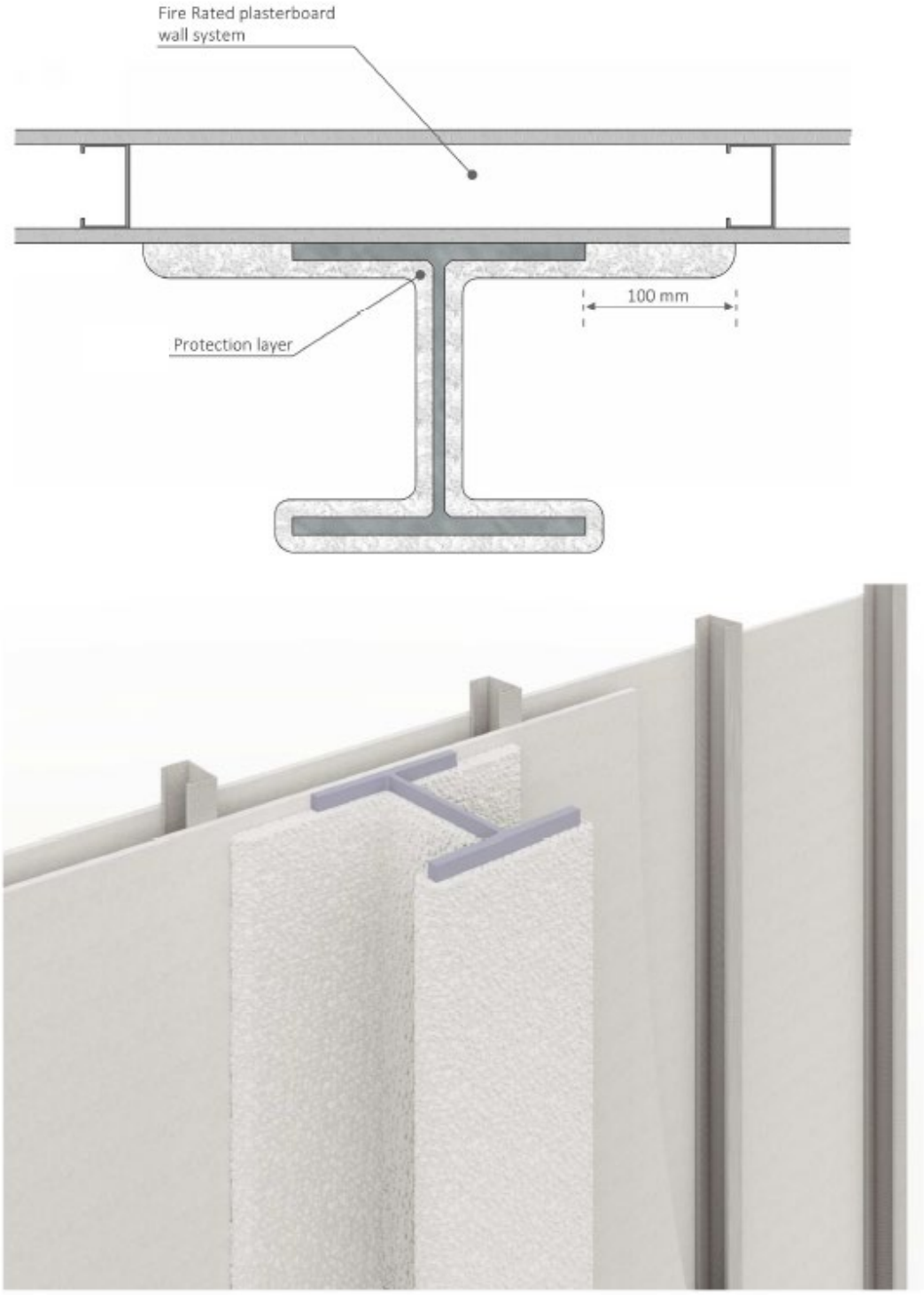


Figure 3 PERLIFOC HP Eco+ or PYROCRETE 60 spray protected steel column interfacing with fire rated board wall systems

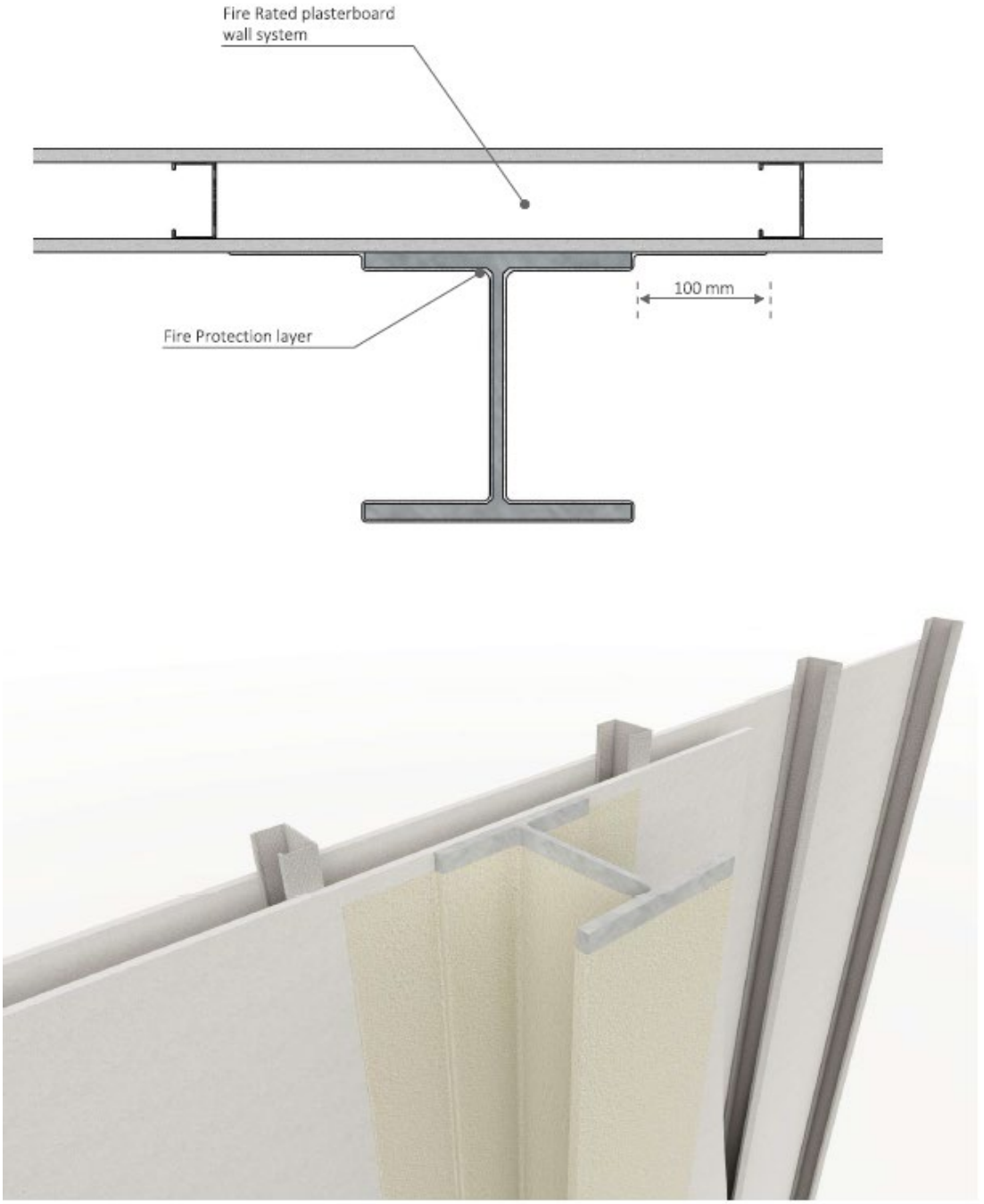


Figure 4 Nullifire SC901/902 protected steel column interfacing with fire rated board wall systems

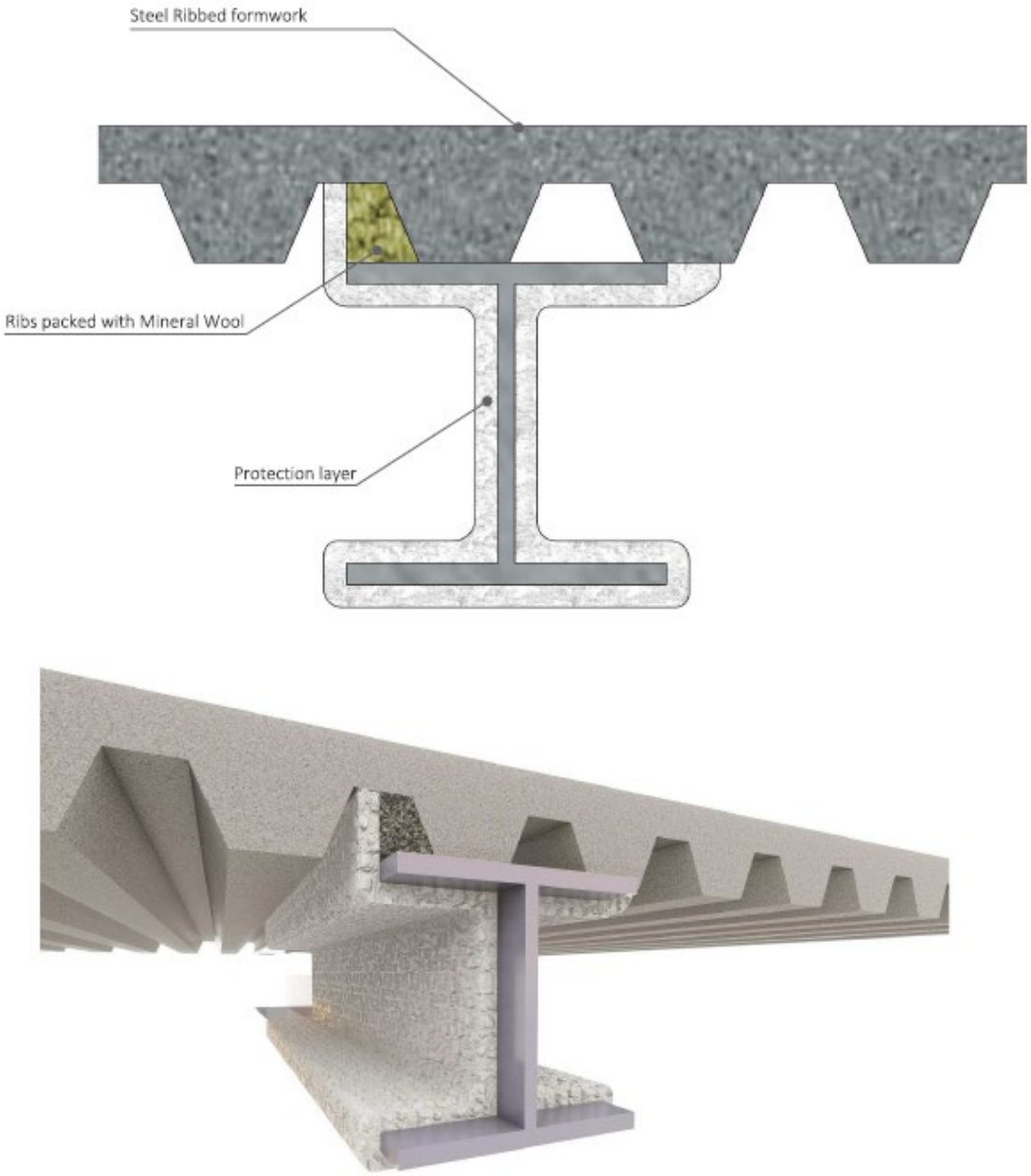


Figure 5 PERLIFOC HP Eco+ or PYROCRETE 60 spray protected steel beam interfacing with composite floor – Steel beam parallel to voids

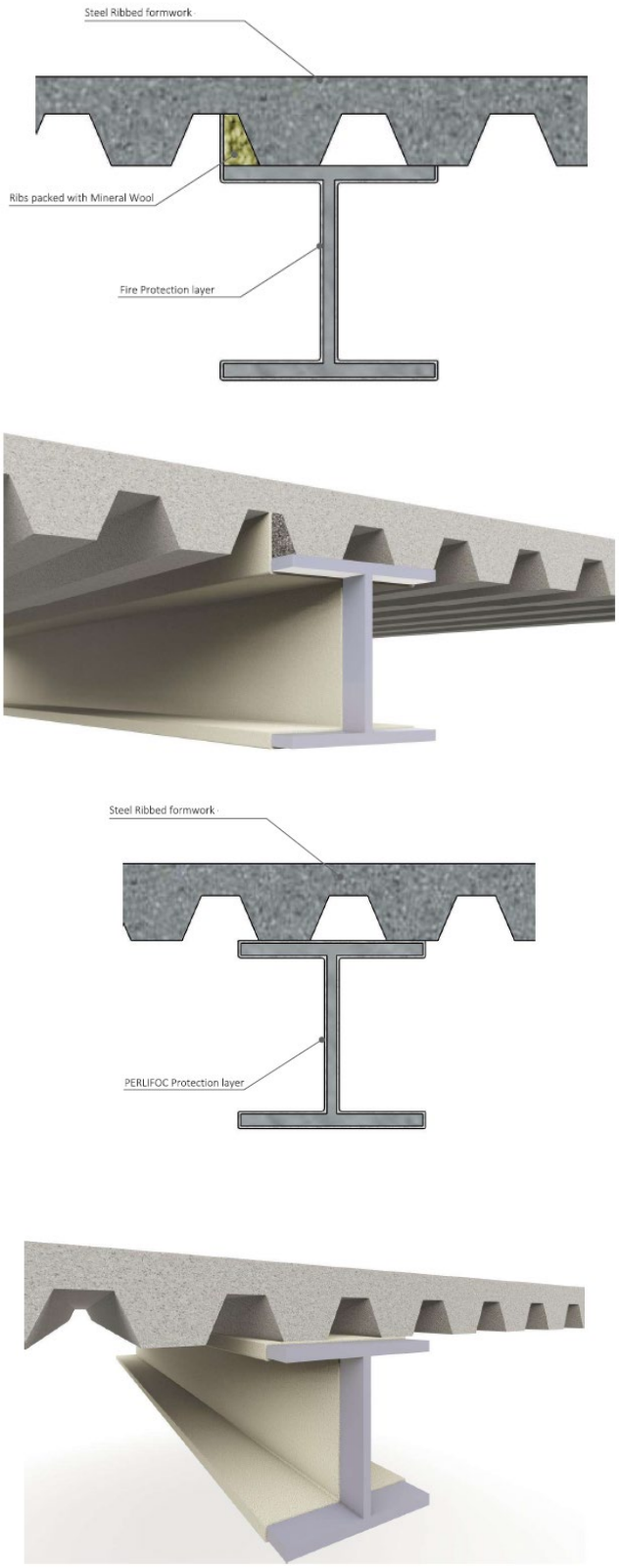


Figure 6 Nullifire SC901/902 protected steel beam interfacing with composite floor – Steel beam parallel to voids

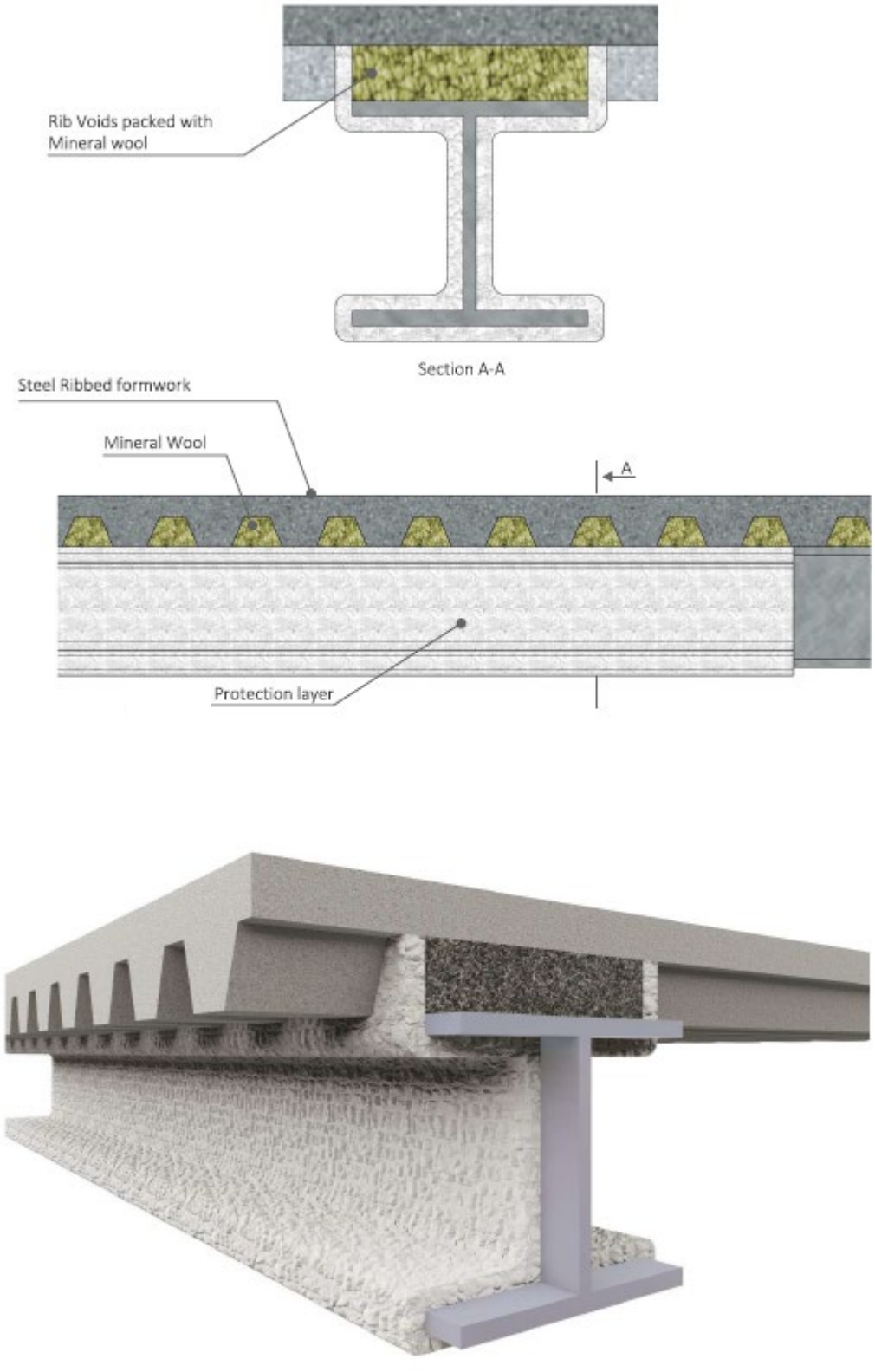


Figure 7 PERLIFOC HP Eco+ or PYROCRETE 60 spray protected steel beam interfacing with composite floor – Steel beam perpendicular to voids

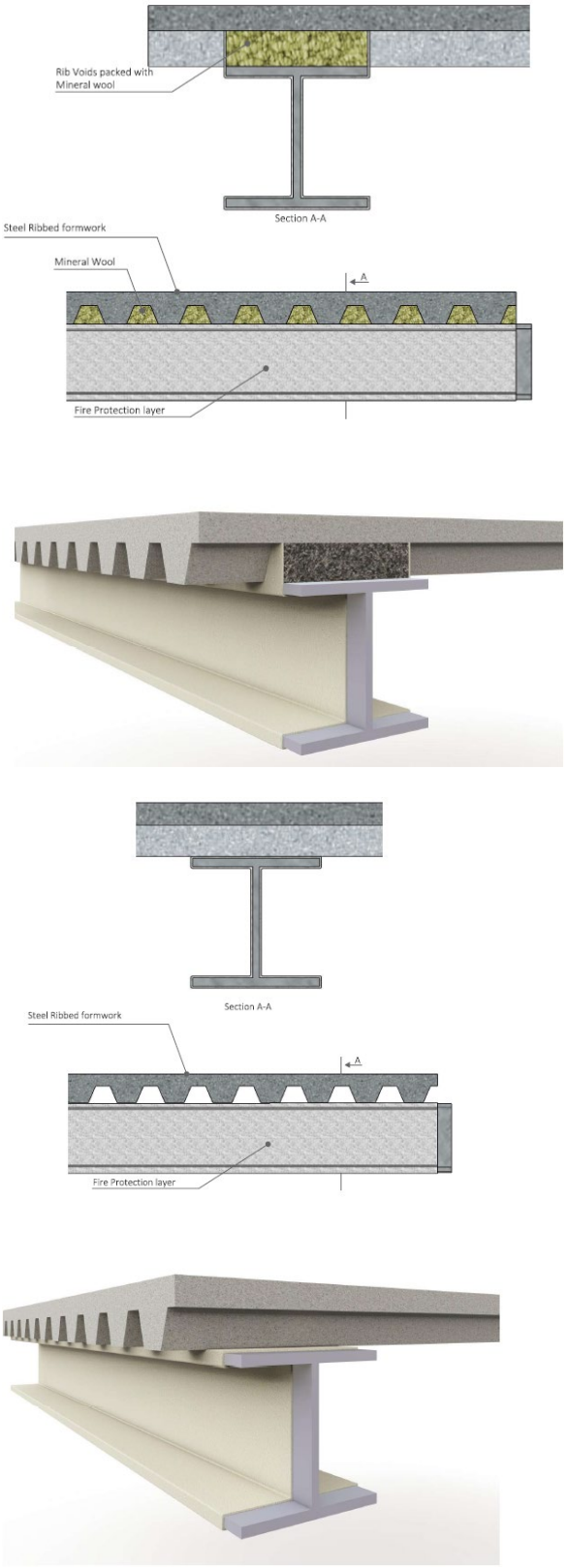


Figure 8 Nullifire SC901/902 protected steel beam interfacing with composite floor – Steel beam perpendicular to voids

4.2 Discussion on PERLIFOC HP Eco+, PYROCRETE 60 or Nullifire SC901/902 protected steel column and masonry wall

Figure 1 shows the interface detail between a PERLIFOC HP Eco+ or PYROCRETE 60 spray protected steel column and a masonry wall. Similarly, Figure 2 shows the interface detail between a Nullifire SC901/902 intumescent coating protected steel column and a masonry wall.

The fire performance of structural steel members protected with PERLIFOC HP Eco+ spray and PYROCRETE 60 spray have been assessed in accordance with AS 4100:2020 as documented in BRANZ fire assessment report FC15622-01-4 and FC20361-01-1, respectively. Similarly, the fire performance of structural steel members protected with Nullifire SC901/902 intumescent coating has been assessed in accordance with AS 4100:2020 as documented in BRANZ fire assessment report FC18580-01-01.

According to these assessments, PERLIFOC HP Eco+ and PYROCRETE 60 sprays can provide structural adequacy levels of up to 240 minutes for steel columns, provided all four sides of the member are appropriately protected. Similarly, Nullifire SC901/902 intumescent coating can provide structural adequacy levels of up to 120 minutes for steel columns.

For columns, full encapsulation – i.e., fire protection on all four sides – is required to achieve the rated performance. In contrast, for beams with concrete floor systems, the fire assessment allows for protection on only three sides. This is based on the understanding that the top flange of the beam is thermally insulated by the concrete slab, which inherently contributes to fire resistance.

A similar principle can be applied in the current construction scenario involving a PERLIFOC HP Eco+, PYROCRETE 60 or Nullifire SC901/902 protected steel column interfacing with a masonry wall. In this application, one face of the column is directly abutted against a fire-rated masonry wall, which is expected to provide equivalent thermal and fire shielding performance. The remaining three exposed faces of the column will be coated with PERLIFOC HP Eco+, PYROCRETE 60 or Nullifire SC901/902 as per the application guidelines.

From a fire protection perspective, this arrangement effectively ensures that all four sides of the column are protected – three sides by PERLIFOC HP Eco+, PYROCRETE 60 or Nullifire SC901/902 and one side by the masonry wall. Given the masonry wall's inherent fire resistance properties and its ability to limit heat transfer to the structural steel, it is reasonable to conclude that this configuration will not compromise the fire resistance performance of the protected column.

Therefore, provided the application is consistent with the conditions and limitations outlined in the referenced fire assessment report, the proposed detail is not expected to compromise the intended fire resistance of PERLIFOC HP Eco+, PYROCRETE 60 or Nullifire SC901/902 protected steel column.

It is a requirement of this assessment that the masonry wall interfacing with the steel column must have an FRL that is at least equal to that of the protected steel column.

4.3 Discussion on PERLIFOC HP Eco+, PYROCRETE 60 or Nullifire SC901/902 protected steel column and fire rated board wall system

Figure 3 shows the interface detail between a PERLIFOC HP Eco+ or PYROCRETE 60 spray protected steel column and fire rated board wall system. Similarly, Figure 4 shows the interface detail between a Nullifire SC901/902 intumescent coating protected steel column and fire rated board wall system.

As with masonry wall systems, it is expected that a fire-rated board wall system (including fire rated plasterboard wall systems) interfacing with a PERLIFOC HP Eco+, PYROCRETE 60 or Nullifire SC901/902 protected steel column will provide thermal protection to the side of the column in contact with the wall. This assumes the board wall system has been tested or assessed to achieve at least the same fire resistance level as the steel column.

Given board wall systems have a tendency to deflect during fire exposure, to enhance the fire performance of the interface and ensure continuity of protection, PERLIFOC HP Eco+, PYROCRETE 60 or Nullifire SC901/902 must extend at least 100 mm onto the surface of the board wall. This overlap helps mitigate the risk of heat ingress or edge effects at the junction between the spray-protected surfaces and the wall system. This also ensures a degree of thermal insulation continuity around the column perimeter, minimizing the likelihood of premature failure at the interface region.

The wall and spray system must be installed in accordance with their respective manufacturers' guidelines. When these measures are implemented appropriately, the overall assembly is not expected to compromise the fire resistance performance of the protected steel column.

It is a requirement of this assessment that the fire rated board wall system interfacing with the steel column must have an FRL that is at least equal to that of the protected steel column.

4.4 Discussion on PERLIFOC HP Eco+, PYROCRETE 60 or Nullifire SC901/902 protected steel beam and composite floor system

Figure 5 to Figure 8 show the interface detail between a PERLIFOC HP Eco+, PYROCRETE 60 or Nullifire SC901/902 protected steel beam and composite floor systems. In this section, two construction scenarios have been considered based on the orientation of the steel beam relative to the voids within the composite slab:

- Beams parallel to slab voids
- Beams perpendicular to slab voids

Guidelines from the 5th edition of the Fire protection for structural steel in buildings – ASFP Yellow Book[1] was used in this section.

Beams installed parallel to voids

Figure 5 and Figure 6 show the construction details where a PERLIFOC HP Eco+, PYROCRETE 60 or Nullifire SC901/902 protected steel beam is installed parallel to the voids in a composite floor system.

The period of structural adequacy for a steel beam protected with PERLIFOC HP Eco+, PYROCRETE 60 or Nullifire SC901/902 applied to three exposed sides can be determined based on the referenced fire assessment reports FC15622-01-4, FC20361-01-1, or FC18580-01-01, respectively. These assessments are valid where the top side of the top flange is protected from direct fire exposure, such as when the beam supports a flat slab.

However, in the proposed construction scenario shown in Figure 5 and Figure 6, where the beam supports a ribbed slab with longitudinal voids, the situation becomes more complex. In this case, the top flange of the beam runs beneath the air-filled voids within the slab, and since these voids are directly open to the fire-exposed soffit, there is potential for localized heat transfer between the heated void air and the top flange of the steel beam. This condition increases the heated perimeter of the steel section, which in turn increases the section factor (Hp/A) and the rate of temperature rise, potentially reducing the structural adequacy period.

To address this risk, few practical sealing strategies are proposed to prevent the ingress of hot gases into the voids above the beam:

For spray protected beams (i.e. PERLIFOC HP Eco+ and PYROCRETE 60)

- Mineral wool: Where the beam top flange aligns within a void, it is recommended that the void space above the beam be completely filled with mineral wool along the beam length, as shown in Figure 5. This will act as a thermal barrier, preventing hot gases from circulating and transmitting heat to the top flange.

[1] Association for Specialist Fire Protection (ASFP), 2014, Fire protection for structural steel in buildings – Yellow book, 5th Edition, Hampshire UK.

- Spray infill or fire rated sealant: If the voids are small or difficult to access with mineral wool, they must be completely filled with the same fire spray material used for the beam (PERLIFOC HP Eco+ and PYROCRETE 60) or a suitable fire-rated sealant.

For intumescent coated steel (i.e. Nullifire SC901/902)

- Mineral wool: Similar to the spray-protected beams, mineral wool infill should be used along the beam where it aligns with voids in the metal decking, as shown in Figure 6.
- Coating: As an alternative, the entire exposed top flange, must be coated with the same thickness of Nullifire SC901/902 as applied to the rest of the beam, as shown in Figure 6. For off-site intumescent applications, this means the full beam section – including the top flange –must be protected prior to installation.

Once the void filling treatment is done, PERLIFOC HP Eco+, PYROCRETE 60 or Nullifire SC901/902 is proposed to be applied on top of the void treatment as well. Additionally, in scenarios where the steel beam flange flushes with the solid portion of the ribbed slab (i.e., where no voids are present), the PERLIFOC HP Eco+, PYROCRETE 60 or Nullifire SC901/902 should be extended further along the rib to ensure continuous fire protection and to close off any potential gaps between the steel beam and floor system.

Both detailing options aim to prevent direct fire exposure or indirect heating of the top flange from the voids. Ensuring that these voids are effectively sealed maintains the classification of the steel beam as being exposed to three sides only, thereby preserving the assumed section factor and limiting the temperature rise.

Therefore, it is concluded that the proposed construction detailing is not detrimental to the structural adequacy of the steel beam and remains consistent with the fire performance assumptions used in the fire assessment of the PERLIFOC HP Eco+, PYROCRETE 60 or Nullifire SC901/902 system.

Beams installed perpendicular to voids

Figure 7 and Figure 8 show the construction detail for a PERLIFOC HP Eco+, PYROCRETE 60 or Nullifire SC901/902 protected steel beam installed perpendicular to the voids in a composite floor system.

In this arrangement, the slab ribbing results in discrete, regularly spaced voids running perpendicular to the steel beam. These voids intersect the beam along its length, creating continuous points of potential exposure at each rib interface. As with beams parallel to voids, the fire performance of the top flange may be compromised due to heat transfer from these air-filled cavities if left unsealed.

According to the fire assessment reports FC15622-01-4, FC20361-01-1, or FC18580-01-01, steel beams protected on three sides are expected to achieve specified periods of structural adequacy, provided that the top flange remains shielded from fire exposure, such as by a solid slab or concrete topping. In this case, however, the perpendicular voids expose parts of the top flange at intervals, increasing the effective heated perimeter, section factor, and rate of heating.

To mitigate this, few practical sealing strategies are proposed:

For spray protected beams (i.e. PERLIFOC HP Eco+ and PYROCRETE 60)

- Mineral wool: The void space above the beam must be completely filled with mineral wool along the beam length, as shown in Figure 7.
- Spray infill or fire rated sealant: For smaller voids where mineral wool cannot be used, it is proposed to use the same spray product (PERLIFOC HP Eco+ and PYROCRETE 60) or fire rated sealant to fill these voids.

For intumescent coated steel (i.e. Nullifire SC901/902)

- Mineral wool: Similar to the spray-protected beams, mineral wool infill must be used along the beam to fill voids as shown in Figure 8.

- Coating: As an alternative, the entire exposed top flange, must be coated with the same thickness of Nullifire SC901/902 as applied to the rest of the beam as shown in Figure 8. For off-site intumescent applications, this means the full beam section – including the top flange –must be protected prior to installation.

These measures will prevent hot gases from entering the voids and transferring heat to the beam's top flange. Once the voids are packed, the PERLIFOC HP Eco+, PYROCRETE 60 or Nullifire SC901/902 must be applied continuously over the void protection and steel interface, creating a uniform fire protection layer.

By incorporating these measures, the localised increase in heating along the top flange due to slab void exposure is effectively addressed. As such, this construction detail ensures that the fire resistance performance of the PERLIFOC HP Eco+, PYROCRETE 60 or Nullifire SC901/902 protected steel beam is not adversely affected, and the system remains consistent with the assumptions used in the referenced fire resistance assessment report.

4.5 Conclusion

Based on the discussion presented, it is the professional opinion of Halliwell Fire Research that the proposed construction details for PERLIFOC HP Eco+, PYROCRETE 60 or Nullifire SC901/902 protected structural steel members – when installed in accordance with the manufacturer's instructions and the guidance provided in the relevant fire assessment report – are not expected to compromise the fire resistance performance of the system, if tested in accordance with AS 1530.4:2014.

Appendix A Experience and Qualifications of Halliwell Fire Research

Halliwell Fire Research are a group of highly qualified international experts in fire safety science and engineering with extensive experience in passive fire product/system development, fire testing and fire assessments. Our team is well-versed in providing research-based expert services related to fire testing and fire assessments conforming to Australian, New Zealand and European test standards.

Table 2 Tabular summary of contributors to this report

Role	Personnel	Qualifications and relevant experience
Author	Dr. Imran Ahamed	BSc (Civil Engineering) PhD (Structural Fire Engineering) CPEng (Structural and Fire Safety) MIEAust NER, RPEQ, RPEV IFE Level 3 Certificate in passive fire protection 8+ years of experience in fire testing and assessments
Reviewer	Dr. Ryan Hilditch	BSc (Fire Safety Engineering) PhD (Fire Safety Engineering) CPEng (Fire Safety) MIEAust NER, RPEQ, APEC Eng, IntPE(Aus) 15 years of experience in fire safety strategy and quantitative assessments