DINCEL WALL

FIRE ASSESSMENT

DISCLAIMER

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Revision	Date	Amendment
A	May 2010	Added Non-Combustibility Assessment by CSIRO
B	June 2010	Added Hydro Carbon Fire
C	January 2017	General Revision

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SUMMARY

The fire performance of DINCEL® - WALL has been assessed by:

1. Fire Resistance Periods

The University of New South Wales' Certificate and Report (Reference No: 5), CSIRO Certificate FSV1346 (Reference No: 6) for Fire Resistance Periods.

The letter of assessment by CSIRO FCO-2674 (Reference No: 4) states that polymer web links of Dincel-Form when concrete filled will not burn or melt away to create holes when subjected to fire conditions. This means that the presence of polymer links within the concrete joining each face of the polymer formwork does not compromise the FRP components of ……./integrity/insulation.

The polymer links of Dincel-Form are maximum 2mm thickness. These polymer links in some other systems are much thicker (more than 10mm). **As proven by tests, the thicker the polymers, the more fuel to burn. The Certifiers therefore should require test results for any polymer links particularly exceeding 2mm thickness.**

2. Fire Hazard Properties

Attachments and Liners to the walls must comply with BCA – Specification C.1.10 {Reference No: 3 (A) and 3 (B)} for Flammability and Smoke issues. As shown in the attached CSIRO certificate, Dincel is a GROUP 1 material (i.e. no limitations for its use in any place without any protection). Dincel's smoke criteria is better than what is allowed by the BCA.

The abovementioned certificates clearly state that **Dincel-Polymer has no limitations on its use for flammability and smoke generation.**

3. Non-Combustibility

The BCA requires the use of non-combustible materials to limit the fire load and fire spread.

It is also important to note that the subject combustibility compliance is only applicable to façade walls in accordance with the BCA.

The letter of assessment by CSIRO FCO-2800 (Reference No: 8) states that the **Dincel-Polymer is the equivalent of the deemed to non-combustible materials in Clause C1.12 of the BCA.**

The BCA recognises DTS = Performance Solution (previously called Alternative Solution). **REQUEST DINCEL'S COMBUSTIBILITY REPORT if your project consists of Dincel façade walls to satisfy the non-combustibility requirement.**

4. Bushfire Prone Areas

The letter of assessment by CSIRO FCO-2755 (Reference No: 7) states that when Dincel Forms are filled with concrete it will comply with AS3959 – 2009 and allowed to be used in all bushfire conditions, including Bushfire Attack Level of BAL-FZ (i.e. the worst bushfire level).

Readers may refer to the following for further information.

DINCEL®-WALL AND FIRE PERFORMANCE

DINCEL®-WALL is a permanent polymer formwork for concrete filling.

Dincel-Polymer forms DO NOT provide fire rating but the CONCRETE DOES.

The concrete infill of DINCEL®-WALL provides the appropriate provisions. The requirement is, BCA – Clause A 2.3 – Fire Resistance of Building Elements, Clause 2.d (ii) – Fire Resistance Period (FRP) of a structural concrete wall shall be determined in accordance with Australian Standard AS3600 for Concrete Structures as certified by The University of New South Wales (UNSW) (Reference No: 5).

There are three (3) components that are required to be identified for the FRP.

- **Insulation and Integrity** – determined in accordance with AS3600 or a Fire Testing Laboratory.

- **Structural Adequacy** – determined in accordance with AS3600 for walls subject to the "deemed to satisfy" condition or a Fire Testing Laboratory can determine this criterion only up to the limits of the testing facility (i.e. applied load and eccentricity, wall height). Fire testing results for walls will not cover building structures of more than 3 to 4 storeys in height and wall heights greater than 3m. Under these circumstances the certifier should not accept the FRP determined by test results. Only concrete wall systems that are compliant with AS3600 can be accepted beyond the test results.

  For fire test results to be accepted, the test sample element must be in strict compliance with AS3600. AS3600 – 2009 – Supplement 1 : 2014 states *"protective coating of concrete is outside the scope of AS3600 – 2009"*, **which means that the certifier cannot accept any fire test results for systems that are reliant on waterproofing.**

Refer **(download) Dincel Wall Building Code of Australia Compliance, pages 2, 3 and 4** for further explanation.

DINCEL®-WALL complies with the Deemed-To-Satisfy condition of the Building Code of Australia in accordance with the certificate by the UNSW (Reference 5).

The CSIRO Certificate (Reference No: 6) has been organised to validate that Dincel-Form's web-links will not burn or melt away to create holes so that the Fire Resistance Period of DINCEL®-WALL for ……./integrity/insulation are not affected (Reference No: 4).

The Dincel-Polymer formwork holds the wet concrete until it sets. If for some reason Dincel-Polymer is required to be removed or even burns during a fire event, the remaining core component is ordinary concrete which provides the required Fire Resistance Period for structural adequacy/integrity/insulation. Therefore, the presence of Dincel-Polymer remaining at the face of the concrete wall can be considered as nothing more than a lining or wall cladding material.

Summary of FRP's for 275mm Dincel, 200mm Dincel, 155mm Dincel and 110mm Dincel Walls (i.e. Concrete Walls) is as follows:

Insulation (AS3600 – Concrete Structures Code – Table 5.7.1 – Fire Resistance Periods for Walls for Insulation):

- 275mm Dincel has concrete thickness of 270mm. **Therefore, Fire Resistance Period for Insulation = 240 minutes** (minimum concrete thickness of 175mm is required for 240 minutes).
- 200mm Dincel has concrete thickness of 187mm. **Therefore, Fire Resistance Period for Insulation = 240 minutes** (minimum concrete thickness of 175mm is required for 240 minutes).
- 155mm Dincel has concrete thickness of 150mm. **Therefore, Fire Resistance Period for Insulation = 180 minutes** (minimum concrete thickness of 150mm is required for 180 minutes).
- 110mm Dincel has concrete thickness of 105mm. **Therefore, Fire Resistance Period for Insulation = 90 minutes** (minimum concrete thickness of 100mm is required for 90 minutes).

Integrity:

If both Insulation and Structural Adequacy is satisfied, AS3600 states that this condition is satisfied as well.

Structural Adequacy:

The FRP for Structural Adequacy is NO LONGER determined by the concrete thickness alone, in accordance with AS3600-2009. The FRP for structural adequacy must be calculated by a Structural Engineer, giving consideration to the wall thickness, wall height, load on the wall, loading eccentricity on the wall and concrete grade.

Therefore, the following FRP's could be achieved:

- **275mm Dincel Wall – 240/240/240.**
- **200mm Dincel Wall – 240/240/240.**
- **155mm Dincel Wall – 180/180/180.**
- **110mm Dincel Wall – 90/90/90.**

The "Structural Adequacy" component of the FRP is to be calculated and confirmed by the project Structural Engineer.

The Non-Combustibility of DINCEL®-WALL

DINCEL®-WALL consists of concrete infill and permanent polymer formwork. The concrete infill material is non-combustible. **The question that must be answered is: – If Dincel-Polymer is used without any protection** (i.e. sprinklers and/or non-combustible materials such as plasterboard, fibre cement sheets, etc.), **does the BCA prohibit or limit the use of DINCEL®-WALL as a building product?** In other words, in accordance with Reference 1, BCA is looking for the non-combustibility conditions if the presence of Dincel-Polymer increases fire load, smoke and fire spread.

A combustibility performance solution in accordance with the BCA has been carried out for the Dincel Wall. This performance solution determines that the Dincel Wall when assessed in accordance with the requirements of the BCA is deemed to be non-combustible. A COPY OF THE COMBUSTIBILITY PERFORMANCE SOLUTION REPORT IS AVAILABLE UPON REQUEST BY PRINCIPAL CERTIFIERS.

References

(1) Non-Combustibility in the Building Code of Australia (BCA) Implications FOR A NEW GLOBAL STANDARD

Jane Blackmore – Fire Science and Technology Laboratory (FSTL), CSIRO, Australia.

(2) Fire Code Research Program – Project 2 – Fire Performance of Materials (Technical Report FCRC – TR 95-01) prepared by V.P. Dowling and C Caird Ramsay CSIRO Division of Building, Construction and Engineering.

(3) CSIRO Certificate (HF07ANK4245 and No: 439) and Report Number FNK 0065. The Certificate for the report is attached to this assessment. If required the full report can be provided.

(4) CSIRO Letter of Assessment of FCO-2674 for fire performance.

(5) Certificate and Report by the University of New South Wales Consulting Services. **Download – Structural Engineering Design Certification**

(6) Certificate of Test by CSIRO, Report No: FSV1346 and Appendix 5. (Refer attached document to this assessment).

(7) CSIRO Letter of Assessment FCO-2755 for Bushfire Prone Areas.

(8) CSIRO Letter of Assessment FCO-2800 for Non-Combustibility.

REFERENCE NO: 3

BCA SPECIFICATION C1.10 – Table 3
WALL LINING MATERIALS (Material Groups Permitted)

BCA Building Class	Fire isolated exits	Public corridors	Specific areas	Other areas
	Wall	Wall	Wall	Wall
Class 2 & 3				
Excluding accommodation for the aged, people with disabilities and children				
Unsprinklered	1	1, 2	1, 2, 3	1, 2, 3
Sprinklered	1	1, 2, 3	1, 2, 3	1, 2, 3
Class 3 & 9a				
Accommodation for the aged, people with disabilities, children and Health-care buildings				
Unsprinklered	1	1	1, 2	1, 2, 3
Sprinklered	1	1, 2	1, 2, 3	1, 2, 3
Class 5, 6, 7, 8 & 9b Schools				
Unsprinklered	1	1, 2	1, 2, 3	1, 2, 3
Sprinklered	1	1, 2, 3	1, 2, 3	1, 2, 3
Class 9b – other than schools				
Unsprinklered	1	1	1, 2	1, 2, 3
Sprinklered	1	1, 2	1, 2, 3	1, 2, 3
Class 9c				
Sprinklered	1	1.2	1, 2, 3	1, 2, 3

Notes:

1. "Sprinklered" refers to a building fitted with a sprinkler system complying with Specification E1.5.
2. "Specific areas" means within –
   (a) for Class 2 and 3 buildings, a sole-occupancy unit; and
   (b) for Class 5, open-plan offices with a minimum floor dimension/floor to ceiling height ratio > 5; and
   (c) for Class 6, shops with a minimum floor dimension/floor to ceiling height ratio > 5; and
   (d) for Class 9a health care buildings, patient care areas; and
   (e) for Class 9b theatres and hall etc., an auditorium; and
   (f) for Class 9b schools, a classroom; and
   (g) for Class 9c aged care buildings, resident use areas.

CSIRO fire testing results in accordance with AS 3837 confirms that DINCEL® consists of Group 1 material and its Specific Extinction Area (SEA) is less than 250m²/kg to comply with the requirements of the Building Code of Australia specification C1.10 Clause 4 Fire Hazard Properties for walls. (Refer to following certificate by CSIRO)

Group 1 material Classification refers to compliance with the above table of Building Code of Australia that the product can be used in any location for any sprinklered or unsprinklered building and will meet the requirements of Specification C1.10 – Clause 4 of current BCA.

The following certificate by CSIRO confirms that Dincel permanent formwork product material is classified as Group 1.

REFERENCE NO: 3 (A) – 1.5MM MATERIAL THICKNESS

Certificate of Assessment

HF07ANK4245

No. 439

This is to certify that the specimen described below was tested by the CSIRO Division of Manufacturing and Infrastructure Technology in accordance with Australian/ New Zealand Standard 3837, Method of test for heat and smoke release rates for materials and products using an oxygen consumption calorimeter, 1998, at 50 kW/m², on behalf of:

Dincel Construction System Pty Ltd
Level 3, 7K Parkes Street
PARRAMATTA NSW
AUSTRALIA

A full description of the test specimen and the complete test results are detailed in the Division's sponsored investigation report numbered FNK 0065.

SAMPLE IDENTIFICATION: Dincel - Formwork

DESCRIPTION OF SAMPLE: The sponsor described the tested specimen as an extruded rigid PVC profile filled with normal density concrete. The specimen contained smoke suppressant additives.

Nominal thickness of PVC:	1.5 mm
Nominal total thickness:	50 mm
Nominal density of PVC:	1.45 g/cm³
Nominal density of concrete:	2400 kg/m³

SAMPLE CLASSIFICATION: Group Number: Group 1
(In accordance with Specification A2.4 of the Building Code of Australia.)

Average specific extinction area: 90.5 m²/kg
(Refer to Specification C1.10a section 3(c) of the Building Code of Australia.)

Testing Officer: Russell Collins Date of Test: 20 November 2003

Issued on the 8th day of February 2007 without alterations or additions. This issue supersedes issue dated 27 November 2003.

Garry E Collins
Manager, Fire Testing and Assessments

CSIRO

CSIRO Manufacturing & Infrastructure Technology
14 Julius Avenue, Riverside Corporate Park, North Ryde NSW 2113 AUSTRALIA
Telephone: 61 2 9490 5444 Facsimile: 61 2 9490 5555

REFERENCE NO: 3 (B) – 2.6MM MATERIAL THICKNESS

Certificate of Assessment

Job No.: NK7381

No. 2220

This is to certify that the specimen described below was tested by the CSIRO Infrastructure Technologies in accordance with Australian/ New Zealand Standard 3837, Method of test for heat and smoke release rates for materials and products using an oxygen consumption calorimeter, 1998, at 50 kW/m², on behalf of:

Dincel Construction System Pty Limited
101 Quarry Road
ERSKINE PARK NSW 2759
AUSTRALIA

A full description of the test specimen and the complete test results are detailed in the Division's sponsored investigation report numbered FNK 11446.

SAMPLE IDENTIFICATION: The sponsor identified the specimen as Dincel Sample A - Current Australian Use.

DESCRIPTION OF SAMPLE: The sponsor described the tested specimen as extruded rigid polyvinyl chloride (PVC) profile used as permanent formwork for concrete walls. The rigid PVC profile formed the exposed face of the tested specimen and was attached onto the concrete block substrate using concrete fasteners at the corner edges of the exposed face.

Nominal thickness of PVC:	2.6-mm
Nominal total thickness:	50-mm
Nominal density of PVC:	1500 kg/m³
Nominal total mass:	100 kg/m²
Colour:	off-white (PVC)

SAMPLE CLASSIFICATION: Group Number: Group 1
(In accordance with Specification A2.4 of the Building Code of Australia.)

Average specific extinction area: 143.6 m²/kg
(Refer to Specification C1.10 section 4(c) of the Building Code of Australia.)

Testing Officer: Heherson Alarde Date of Test: 21 July 2015

Issued on the 3rd day of August 2015 without alterations or additions.

Brett Roddy
Team Leader, Fire Testing and Assessments

NATA Accredited Laboratory
Number: 165
Corporate Site No 3625
Accredited for compliance with ISO/IEC 17025.

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REFERENCE NO: 4 – 08 DECEMBER, 2014

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CSIRO

Likely performance of the Dincel-Form concrete filled wall system

Assessment Report

Author: Mario Lara-Ledermann
Report number: FCO-2674
Date: 8 December 2014
(This issue supersedes that dated 4 May 2009)

Client: Dincel & Associates Pty Ltd

Commercial-in-confidence

REFERENCE NO: 4 – 08 DECEMBER, 2014

Inquiries should be address to:

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Report Details:

Report CSIRO Reference number: FCO-2674/CO4489

Report Status and Revision History:

VERSION	STATUS	DATE	DISTRIBUTION	ISSUE NUMBER
Revision A	Final for issue	8/12/2014	CSIRO/Client	FCO-2674

Report Authorization:

AUTHOR	REVIEWED BY	AUTHORISED BY
Mario Lara-Ledermann	Brett Roddy	Brett Roddy
8 December 2014	8 December 2014	8 December 2014

Copyright and disclaimer

Important disclaimer

This assessment report will lapse on 31 December 2019. Should you wish us to re-examine this report with a view to the possible extension of its term of validity, would you please apply to us three to four months before the date of expiry. This Division reserves the right at any time to amend or withdraw this assessment in the light of new knowledge.

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REFERENCE NO: 4 – 08 DECEMBER, 2014

Contents

REFERENCE NO: 4 – 08 DECEMBER, 2014

Executive summary

This report provides the assessment of this Division on the likely performance of the Dincel-Form concrete filled wall system.

You propose to incorporate polymer web links into your polymer formwork based fire tested wall system.

Based on the observed performance under test conditions of the full-scale fire-resistance test it is the opinion of this Division that the temperature would be such that the polymer web links of Dincel-Form when concrete filled will not burn or melt away to create holes when subjected to fire conditions. Thus the presence of web links will not affect the smoke and fire-resistance level (FRL) capacity of Dincel-Wall if tested in accordance with AS 1530.4-2005.

REFERENCE NO: 4 – 08 DECEMBER, 2014

Likely performance of the Dincel-Form concrete filled wall system

1 Introduction

This report provides the assessment of this Division on the likely performance of the Dincel-Form concrete filled wall system.

2 Supporting Data

2.1 CSIRO Sponsored Investigation report numbered FSV 1346

On 26 February 2009, this Division conducted a full-scale fire-resistance test on a wall system comprising a reinforced concrete wall system 3000-mm high x 3000-mm wide x 200-mm thick made up of nine pre-fabricated Dincel-permanent polymer formwork panels filled with insitu concrete after assembly.

The formwork panels measured 333-mm in width x 2-mm in thickness, each module connected to the other via a patented snap engagement mechanism at each joint. The prefabricated panels incorporated 25-mm high x 65-mm base triangular service voids, as well as 115-mm diameter holes spaced at 150-mm centres located in the webbing of the panel.

The panels were put up vertically and appropriately braced before 20 Mpa concrete mix (slump estimated by the client to be in excess of 150-mm) was pumped in through the top in one continuous pour without the use of concrete vibrators, and trowelled off when completely filled. There was no reinforcement bars used in the test wall.

A total load of 800 kN was applied to the specimen for the duration of the test.

The integrity of the wall system was maintained for the full 240 minute duration of the test.

3 Proposal

You propose to incorporate polymer web links into your polymer formwork based fire tested wall system.

4 Analysis

Based on the observed performance under test conditions of the full-scale fire-resistance test it is the opinion of this Division that the temperature would be such that the polymer web links of Dincel-Form when concrete filled will not burn or melt away to create holes when subjected to fire conditions.

5 Conclusion

It is the opinion of this Division that the presence of web links will not affect the smoke and fire-resistance level (FRL) capacity of Dincel-Wall if tested in accordance with AS 1530.4-2005.

6 Term of validity

This assessment report will lapse on 31 December 2019. Should you wish us to re-examine this report with a view to the possible extension of its term of validity, would you please apply to us three to four months before the date of expiry. This Division reserves the right at any time to amend or withdraw this assessment in the light of new knowledge.

REFERENCE NO: 4 – 08 DECEMBER, 2014

References

The following informative documents are referred to in this Report:

AS 1530.4-2005	Methods for fire tests on building materials, components and structures Part 4: Fire-resistance tests of elements of building construction.
FSV 1346	CSIRO Sponsored Investigation report on full-scale fire-resistance test on a wall system comprising a reinforced concrete wall system 3000-mm high x 3000-mm wide x 200-mm thick made up of nine pre-fabricated Dincel-permanent polymer formwork panels filled with insitu concrete after assembly conducted on 26 February 2009.

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REFERENCE NO: 5

23rd July 2014

Our Ref: J084829

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BSc., B.E., PhD., D.Sc., FTSE
Centre for Infrastructure Engineering and Safety
PROFESSOR OF CIVIL ENGINEERING
AUSTRALIAN LAUREATE FELLOW
SCIENTIA PROFESSOR

Dear Sirs

Dincel Construction System
Structural Engineering Certification

I have conducted an expert review of the Dincel Construction System's Compliance Manual (Building Code of Australia Compliance Assessment and Certifications as appears in the Dincel website), its Structural Engineering Design Manual (3S Structural Engineering Manual) and its Construction Manual for Designers and Builders.

Specifically, the *Compliance Manual* deals with principles regarding compliance with the Building Code of Australia, while the *Structural Engineering Design Manual* addresses material properties as well as the structural design of axially loaded walls subjected to vertical loading in sway prevented structures, flexural members that are subjected to bending and shear effects and shear walls. The *Construction Manual for Designers and Builders* deals with the Dincel Wall components, architectural planning layouts, installation and detailing recommendations.

I note the introduction of a 200mm thick corner profile referred to as 200P-3. I note the reference to AS3700-2011, which supersedes AS3700-2001, and of the removal of designing DINCEL® to AS3700-2011. I note that the equation for calculating the tensile strength of concrete has been modified to 0.36f'c ½. I note the limitation on shear capacity as being the lesser of (0.2f'c, 10 MPa). Finally, I note pages 47 to 52 now provide compressive strength tables in accordance with Section 11 of AS3600-2009, since the limiting values in Clause 5.7.4 (d) (i) in AS3600-2001 have been removed in AS3600-2011.

I am satisfied that the design principles and methodologies in these manuals are appropriate and consistent with the design clauses in the relevant and frequently used international structural engineering codes of practice, such as the ACI 318 and Eurocode EC2 mentioned in the Dincel Construction System's Engineering Manual, and in particular with AS 3600-2009 Concrete Structures.

I am satisfied that the walls and blade columns of the Dincel Construction System, when designed in accordance with the *Structural Engineering Design Manual*, will satisfy the Building Code of Australia Volume 1 Specification A2.3 (2) (d) (ii) "deemed to satisfy" definition, being compliant with AS 3600-2009 Concrete Structures.

Based on the aforementioned evaluation and review, I certify the use of the Compliance Manual and the Structural Engineering Design Manual comply for the purposes of structural engineering design.

Yours faithfully

Mark Bradford.

MARK A BRADFORD
BSc BE PhD DSc FTSE FIStructE FIEAust Dist.MASCE

REFERENCE NO: 6

Certificate of Test

No. 2129

This is to certify that the element of construction described below was tested by the CSIRO Division of Materials Science and Engineering in accordance with Australian Standard 1530, Methods for fire tests on building materials, components and structures, Part 4-2005 on behalf of:

Dincel Construction System Pty Ltd
Level 3, 7K Parkes Street
PARRAMATTA NSW

A full description of the test specimen and the complete test results are detailed in the Division's sponsored investigation report numbered FSV 1346.

Product Name: Permanent polymer form, load-bearing, reinforced concrete wall system.

Description: The specimen comprised a reinforced concrete wall system 3000-mm high x 3000-mm wide x 200-mm thick made up of nine pre-fabricated Dincel-permanent polymer formwork panels filled with insitu concrete after assembly.

The formwork panels measured 333-mm in width x 2-mm in thickness, each module connected to the other via a patented snap engagement mechanism at each joint. As shown in drawing numbered DCS-TP1 Issue A, dated 30 January 2009, by Dincel Construction Systems, the prefabricated panels incorporated 25-mm high x 65-mm base triangular service voids, as well as 115-mm diameter holes spaced at 150-mm centres located in the webbing of the panel.

The panels were put up vertically and appropriately braced before 20 Mpa concrete mix (slump estimated by the client to be in excess of 150-mm) was pumped in through the top in one continuous pour without the use of concrete vibrators, and trowelled off when completely filled.
There was no reinforcement bars used in the test wall.
The wall was left to cure for approximately six months.

The element of construction described above satisfied the following criteria for fire-resistance for the period stated.

Structural Adequacy	-	no failure at 241 minutes
Integrity	-	no failure at 241 minutes
Insulation	-	230 minutes

For the purpose of Building Regulations in Australia, a fire-resistance level (FRL) of 240/240/180 was achieved. The FRL is applicable for exposure to fire from either direction.

This certificate is provided for general information only and does not comply with the regulatory requirements for evidence of compliance.

Testing Officer: Chris Wojcik Date of Test: 26 February 2009.
Issued on the 13ht day of March 2009 without alterations or additions.

Garry E Collins
Manager, Fire Testing and Assessments

CSIRO

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NATA

This document is issued in accordance with NATA's accreditation requirements

APPENDIX 5

Test Performance and Spalling

As noted in the description of the specimen the panels were filled with a nominal 20 Mpa concrete mix with a slump estimated by the client to be in excess of 150-mm. The concrete was pumped in through the top in one continuous pour without the use of concrete vibrators, and trowelled off when completely filled.

The use of concrete with such a high slump and water content resulted in there being a considerable quantity of free water trapped within the wall, particularly in the bottom half. During the conduct of the test the rapid rise in temperature results in this free water being turned into superheated steam and produces spalling of the concrete. This can clearly be seen in Photograph 12, in the main body of the report, where significant spalling was demonstrated approximately 500-mm from the bottom of the specimen.

If the excess water is reduced during the construction phase of the wall then this would significantly reduce the spalling and enhance the performance of the wall system. It is therefore the opinion of this Division that if the slump of the concrete used in the construction of the wall system was less than or equal to 110-mm, during pouring, then the wall system detailed in this report would be capable of achieving fire-resistance levels of 240/240/240 if tested in accordance with AS 1530.4-2005.

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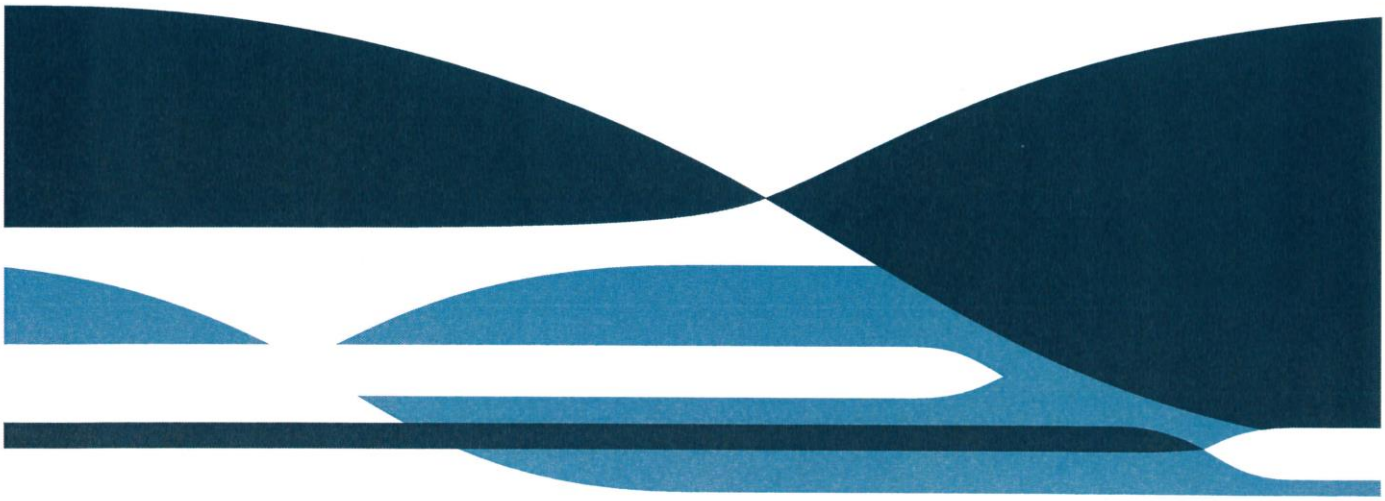
Likely performance of the Dincel-Form concrete filled wall system if tested in accordance with AS 1530.8.2-2007

Assessment Report

Author: Mario Lara-Ledermann
Report number: FCO-2725
Date: 23 February 2015
(This issue supersedes that dated 4 May 2009)

Client: Dincel Construction Systems Pty Ltd

Commercial-in-confidence



REFERENCE NO: 7 – 23 FEBRUARY, 2015

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VERSION	STATUS	DATE	DISTRIBUTION	ISSUE NUMBER
Revision A	Final for issue	23/2/2015	CSIRO/Client	FCO-2725

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AUTHOR	REVIEWED BY	AUTHORISED BY
Mario Lara-Ledermann	Brett Roddy	Brett Roddy
		
23 February 2015	23 February 2015	23 February 2015

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REFERENCE NO: 7 – 23 FEBRUARY, 2015

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REFERENCE NO: 7 – 23 FEBRUARY, 2015

Executive summary

This report provides the assessment of this Division on the likely performance of the Dincel-Form concrete filled wall system.

You propose to determine the likely Bushfire Attack Level (BAL) of the wall system in accordance with AS 1530.8.2-2007.

Based on the performance recorded during the conduct of the full-scale fire-resistance test it is the opinion of this Division that the wall system reported in FSV 1346 would achieve a Bushfire Attack Level of BAL-FZ if tested in accordance with AS 1530.8.2-2007.

REFERENCE NO: 7 – 23 FEBRUARY, 2015

Likely performance of the Dincel-Form concrete filled wall system if tested in accordance with AS 1530.8.2-2007

1 Introduction

This report provides the assessment of this Division on the likely performance of the Dincel-Form concrete filled wall system.

2 Supporting Data

2.1 CSIRO Sponsored Investigation report numbered FSV 1346

On 26 February 2009, this Division conducted a full-scale fire-resistance test on a wall system comprising a reinforced concrete wall system 3000-mm high x 3000-mm wide x 200-mm thick made up of nine pre-fabricated Dincel-permanent polymer formwork panels filled with insitu concrete after assembly.

The formwork panels measured 333-mm in width x 2-mm in thickness, each module connected to the other via a patented snap engagement mechanism at each joint. The prefabricated panels incorporated 25-mm high x 65-mm base triangular service voids, as well as 115-mm diameter holes spaced at 150-mm centres located in the webbing of the panel.

The panels were put up vertically and appropriately braced before 20 Mpa concrete mix (slump estimated by the client to be in excess of 150-mm) was pumped in through the top in one continuous pour without the use of concrete vibrators, and trowelled off when completely filled. There was no reinforcement bars used in the test wall.

A total load of 800 kN was applied to the specimen for the duration of the test.

The system, as tested achieved fire-resistance levels of 240/240/180.

3 Proposal

You propose to determine the likely Bushfire Attack Level (BAL) of the wall system in accordance with AS 1530.8.2-2007.

4 Analysis

Australian Standard 3959 describes the requirements for buildings constructed in bushfire-prone areas in Australia. In that document it defines a series of Bushfire Attack Levels (BAL) ranging from Low through 12.5, 19, 29, 40 to FZ (Fire Zone) in ascending severity of attack. Levels up to BAL-40 are covered in Australian Standard 1530.8.1 and BAL-FZ is covered in Australian Standard 1530.8.2.

AS 1530.8.2 specifies that the test shall be performed in accordance with the requirements of AS 1530.4, except that the test duration is 90 min comprising a 30 min heating phase and a subsequent 60 minutes period during which the performance of the element is monitored.

The specimen shall be exposed to the standard heating regime specified in AS 1530.4. Control of the furnace shall be in accordance with the requirements of AS 1530.4. Within 2 min of termination of heating, the specimen shall be removed from the furnace to enable observation of the fire-exposed face.

With respect to AS 1530.8.2 test criteria, the test specimen reported in FSV 1346 was subjected to the heating conditions of AS 1530.4 for the 30 minutes and was continued to be subjected to the heating conditions of AS 1530.4 for the subsequent 60 minute observation period.

The performance criteria of AS 1530.8.2 are specified in Clause 13.8 and states:

When exposed to the design bushfire conditions, the building exterior shall not permit the following:

(a) Formation of an opening from the fire-exposed face to the non-fire-exposed face of the element through which a 3 mm diameter probe can penetrate for the duration of the 90 min test period.
(b) Sustained flaming for more than 10 s on the non-fire side for the duration of the 90 min test period.
(c) Flaming on the fire-exposed side more than 30 min after termination of the heating phase, that is, flaming on the fire exposed face during the last 30 min of the monitoring phase.
(d) Radiant heat flux 365 mm from the non-fire side of the specimen in excess of 15 kW/m² from glazed and uninsulated areas during the 30 min exposure and for a subsequent 60 min test period.
(e) Mean and maximum temperature rises greater than 140 K and 180 K on the non-fire side during the 30 min heating regime and for a subsequent 60 min period, except for glazed/uninsulated areas for which the radiant heat flux limits are applicable.
(f) Radiant heat flux 250 mm from the fire-exposed face of the specimen, greater than 3 kW/m² more than 30 min after completion of the heating phase, that is, flaming on the fire exposed face during the last 30 min of the monitoring phase.
(g) Mean and maximum temperatures of the internal faces of construction including cavities, exceed 250°C and 300°C, 30 min or more after completion of the heating phase.

Evaluating the performance of the wall reported in FSV 1346 against these criteria shows:

(a) No holes of any size where formed in the wall during the first 90 minutes of the test period;
(b) No sustained flaming on the unexposed face for the first 90 minutes of the test period;
(c) No evaluated but after 30 minutes the exposed face consisted on plain concrete that is non-combustible;
(d) The temperature recorded on the unexposed face at 90 minutes was approximately 67°C from which the received radiation at 365 mm would be approximately 0.7 kW/m²;
(e) The maximum temperature rise and average temperature rise were approximately 65K and 22K, respectively, at 90 minutes;
(f) See (c) above; and
(g) The wall was solid and did not incorporate internal faces.

As can be seen the tested wall would not have failed any of the performance criterion.

5 Conclusion

Based on the performance recorded during the conduct of the full-scale fire-resistance test it is the opinion of this Division that the wall system reported in FSV 1346 would achieve a Bushfire Attack Level of BAL-FZ if tested in accordance with AS 1530.8.2-2007.

6 Term of validity

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References

The following informative documents are referred to in this Report:

AS 1530.4-2005	Methods for fire tests on building materials, components and structures Part 4: Fire-resistance tests of elements of building construction.
AS 1530.8.1-2007	Methods for tests on building materials, components and structures: Part 8.1: Tests on elements of construction for buildings exposed to simulated bushfire attack - Radiant heat and small flame sources.
AS 1530.8.2-2007	Methods for tests on building materials, components and structures: Part 8.2: Tests on elements of construction for buildings exposed to simulated bushfire attack - Large flaming sources
AS 3959	Construction of buildings in bushfire-prone areas .
FSV 1346	CSIRO Sponsored Investigation report on full-scale fire-resistance test on a wall system comprising a reinforced concrete wall system 3000-mm high x 3000-mm wide x 200-mm thick conducted on 26 February 2009.

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Fire performance comparison of Dincel extruded rigid PVC profile/concrete wall and plasterboard

Assessment Report

Author: Russell Collins
Assessment Number: FCO-2800
Quote Number: CO4611

Date: 20 October 2016
Version: Revision E

Client: Dincel Construction Systems Pty Limited

Commercial-in-confidence

REFERENCE NO: 8 – 20 OCTOBER, 2016

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Test Report Authorisation

AUTHOR	REVIEWED BY	AUTHORISED BY
Russell Collins	Brett Roddy	Brett Roddy
		
20 October 2016	20 October 2016	20 October 2016

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Contents

REFERENCE NO: 8 – 20 OCTOBER, 2016

Executive summary

This Division has examined the information referenced by you on the combustibility performance of the Dincel-Form concrete filled wall system in terms of the definition of non-combustible in Clause A1.1 and Clause C1.12 Non-combustible materials of the National Construction Code Series, Volume 1, Building Code of Australia 2015 (BCA).

The Dincel extruded rigid PVC profile/concrete wall was tested by CSIRO at 50 kW/m² irradiance in accordance with AS/NZS 3837:1998, and reported in Test Reports numbered FNK 0065 and FNK 11446. The sponsor identified the specimen as "Dincel – Formwork" with 1.5 mm thick PVC profile and "Dincel Sample A – Current Australian Use" with 2.6 mm thick PVC profile respectively. The Dincel extruded rigid PVC profile/concrete wall was also tested by CSIRO in accordance with AS 1530.4-2005, and reported in Test Report numbered FSV 1346.

The "Dincel – Formwork" and "Dincel Sample A – Current Australian Use" Dincel extruded rigid PVC profile/concrete wall has not been proven to be non-combustible as defined in the BCA, or to satisfy any criteria for materials that, though combustible or containing combustible fibres, may be used wherever a non-combustible material is required as defined in Clause C1.12 of the BCA. Consequently, Dincel Sample A – Current Australian Use" Dincel extruded rigid PVC profile/concrete wall does not meet any of the BCA Deemed-to-Satisfy (DtS) criteria of materials that may be used wherever materials deemed non-combustible are required and this report does not assess the material to be non-combustible in accordance with the BCA DtS criteria.

The "Dincel – Formwork" and "Dincel Sample A – Current Australian Use" Dincel extruded rigid PVC profile/concrete wall, when tested in accordance with AS/NZS 3837:1998 at 50 kW/m² irradiance in the horizontal orientation with edge frame produces comparable or less heat output than some types of plasterboard, a material deemed to be non-combustible in Clause C1.12 of the BCA, and achieves an equivalent group number, as defined in Specification C1.10, Clause 4 of the BCA.

The "Dincel Sample A – Current Australian Use" Dincel extruded rigid PVC profile/concrete wall, produces a greater average specific extinction area, a measure of smoke, than plasterboard when tested to AS/NZS 3837:1998 at 50 kW/m² irradiance. The average specific extinction area value measured was 143.6m²/kg which is less than the allowable smoke provision of 250 m²/kg in BCA Specification C1.10 (4)c(ii) for walls and ceiling linings in buildings not fitted with a sprinkler system.

The comparison in this report does not constitute an alternative solution.

REFERENCE NO: 8 – 20 OCTOBER, 2016

Fire performance comparison of Dincel extruded rigid PVC profile/concrete wall and plasterboard

1 Introduction

This report provides a comparison by this Division on the combustibility performance of the Dincel-Form concrete filled wall system in terms of the definition of non-combustible in Part A1.1 and Clause C1.12 Non-combustible materials of the National Construction Code Series, Volume 1, Building Code of Australia 2015 (BCA).

CSIRO conducted an AS/NZS 3837:1998 test on the Dincel extruded rigid PVC profile/concrete wall at 50 kW/m² irradiance, identified as "Dincel Sample A – Current Australian Use", and reported in Test Report numbered FNK 11446.

The combustibility of this product is assessed against Part A1.1 and Clause C1.12 of the BCA, AS 1530.1, and a comparison to materials that may be used wherever a non-combustible material is required as defined in Clause C1.12 of the BCA.

2 Supporting Data

2.1 CSIRO Test Report numbered FNK 0065

On 20 November 2003 this Division conducted a fire test on "Dincel - Formwork" Dincel extruded rigid PVC profile/concrete wall at 50 kW/m² irradiance in accordance with AS/NZS 3837:1998. CSIRO Test Report numbered FNK 0065, issued 8th February 2007, details the test results. The sponsor described the tested specimen as extruded rigid polyvinyl chloride (PVC) profile used as permanent formwork for concrete walls. The rigid PVC profile formed the exposed face of the tested specimen and was attached onto the concrete block substrate using concrete fasteners at the corner edges of the exposed face.

Nominal thickness of PVC:	1.5-mm
Nominal total thickness:	50-mm
Nominal density of PVC:	1.45 g/cm³
Nominal density of concrete:	2400 kg/m³

FNK 0065 reported that all of the specimens failed to ignite during the test.

CSIRO Certificate of Assessment numbered 439 reported the product achieve a group number of Group 1 in accordance with Specification A2.4 of the Building Code of Australia, and average specific extinction area of 90.5 m²/kg as referenced by Specification C1.10 section 4(c) of the BCA.

2.2 CSIRO Test Report numbered FNK 11446

On 21 July 2015 this Division conducted a fire test on "Dincel Sample A – Current Australian Use" Dincel extruded rigid PVC profile/concrete wall at 50 kW/m² irradiance in accordance with

AS/NZS 3837:1998. CSIRO Test Report numbered FNK 11446, issued 3rd August 2015, details the test results. The sponsor described the tested specimen as extruded rigid polyvinyl chloride (PVC) profile used as permanent formwork for concrete walls. The rigid PVC profile formed the exposed face of the tested specimen and was attached onto the concrete block substrate using concrete fasteners at the corner edges of the exposed face.

Nominal thickness of PVC:	2.6-mm
Nominal total thickness:	50-mm
Nominal density of PVC:	1500 kg/m³
Nominal total mass:	100 kg/m²
Colour:	off-white (PVC)

FNK 11446 reported that all of the specimens failed to ignite during the test. Some flashing was observed on the specimens.

CSIRO Certificate of Assessment numbered 2215 reported the product achieve a group number of Group 1 in accordance with Specification A2.4 of the Building Code of Australia, and average specific extinction area of 143.6 m²/kg as referenced by Specification C1.10 section 4(c) of the BCA.

2.3 BRANZ Fire Test Report FH 4888

On 9 May 2012 this BRANZ conducted a fire test on "Boral Enviro Multistop" 13 mm thick paper faced plasterboard at 50 kW/m² irradiance in accordance with AS/NZS 3837:1998. BRANZ Fire Test Report FH 4888, issued 18 May 2012, details the test results.

Nominal total thickness:	13-mm
Nominal total density:	875 kg/m³ to 894 kg/m³
Colour:	pale cream

FH 4888 reported that all of the specimens ignited during the test; reported the product achieve a group number of Group 1 for the purpose of compliance with the BCA 2011 Specification C1.10; and average specific extinction area of 34.1 m²/kg as referenced by Specification C1.10 Table 2.

2.4 AS 1530.1 – Applicability for Dincel-Form concrete filled wall system

AS 1530.1-1994 is the test standard to determine if a material is deemed 'combustible' as defined in the BCA. AS 1530.1-1994 test samples are cylindrical in shape, 45-mm in diameter and 50-mm high, and are tested in a tube furnace at 750°C. Clause 1.4 of AS 1530.1 states that "...The test method is not applicable to products which are coated, faced or laminated. In such cases, tests may be carried out separately on the individual materials from which the product is formed and this shall be clearly stated in the test report". Furthermore, Clause 2.2.3 states that "If the thickness of the material is less than the required height, specimens of the height specified ... shall be made by using a sufficient number of layers of the material and by adjustment of the material thickness if required."

AS 1530.1-1994 requires measurement of the temperatures of the furnace, specimen interior, specimen surface, and the duration of any flaming during the test. The test continues for at least thirty minutes, then until the temperatures have reached equilibrium. Equilibrium is deemed to be achieved when the temperature change as measured by a thermocouple is no more than two degrees Kelvin over ten minutes, provided that at this stage the specimen centre thermocouple reading is below that of the furnace thermocouple.

The furnace and/or specimen surface temperatures should not show a rise of more than 50°C above their final equilibrium temperatures AND specimens must not show continuous flaming for more than

five seconds to not be deemed combustible. Also, the mass of the specimen immediately before and after the test must be recorded.

To test Dincel-Form extruded rigid PVC profile/concrete wall to AS 1530.1 would require two tests: one on the PVC profile material and one on the concrete core.

2.5 National Construction Code Series, Volume 1, Building Code of Australia 2015 (BCA)

Part A, Clause A1.1 Definitions of the BCA defines combustible as:

"...

(a) Applied to a material — combustible as determined by AS 1530.1.
(b) Applied to construction or part of a building — constructed wholly or in part of combustible materials."

And non-combustible as:

"...

(a) Applied to a material — not deemed combustible as determined by AS 1530.1 – Combustibility Test for Materials; and.
(b) Applied to construction or part of a building — constructed wholly or of materials that are not deemed combustible."

Part C, Clause C1.12 Non-combustible materials states:

"The following materials, though combustible or containing combustible fibres, may be used wherever a non-combustible material is required:

(a) Plasterboard.
(b) Perforated gypsum lath with a normal paper finish.
(c) Fibrous-plaster sheet.
(d) Fibre-reinforced cement sheeting.
(e) Pre-finished metal sheeting having a combustible surface finish not exceeding 1 mm thickness and where the Spread-of-Flame Index of the product is not greater than 0.
(f) Bonded laminated materials where—
  (i) each laminate is non-combustible; and
  (ii) each adhesive layer does not exceed 1 mm in thickness; and
  (iii) the total thickness of the adhesive layers does not exceed 2 mm; and
  (iv) the Spread-of-Flame Index and the Smoke-Developed Index of the laminated material as a whole does not exceed 0 and 3 respectively.

Specification C1.10, Clause 4. Wall and ceiling linings states that:

"...

(a) For the purposes of this Clause, the group number of a material is determined by either—
  (i) ...
  (ii) prediction in accordance with Clause 3 of Specification A2.4 using data obtained by testing the material at 50 kW/m² irradiance in the horizontal orientation with edge frame in accordance with AS/NZS 3837."

3 Analysis

The principal reason for the BCA to stipulate non-combustibility for wall systems is to control the spread of fire along the wall as well as to reduce the contribution of the wall in the initial growth of a fire.

To determine if a material is non-combustible it must be not deemed combustible as determined by AS 1530.1 – Combustibility Test for Materials. The "Dincel – Formwork" and "Dincel Sample A – Current Australian Use" Dincel extruded rigid PVC profile/concrete wall system has not been tested in accordance with AS 1530.1. Consequently, it has not been determined that the Dincel extruded rigid PVC profile/concrete wall system is non-combustible. Organic based products such as plastics will generally be deemed combustible when tested to AS 1530.1.

"Dincel – Formwork" and "Dincel Sample A – Current Australian Use" Dincel extruded rigid PVC profile/concrete wall system has been tested by CSIRO in accordance with AS3837.1998, as reported in CSIRO Test Report numbered FNK 0065 and FNK 11446, and Certificate of Assessment numbered 439 and 2215 respectively. The materials both achieved a Group 1 as defined in Clause 4 of Specification C1.10 of the BCA. This classification permits it to be used in the construction of walls for all classes and types of buildings including fire isolated exits. The material did not ignite when exposed to the test conditions. The peak heat release rate during the FNK 0065 test was 15.5 kW/m² and the total heat release was 4.41 MJ/m²; the peak heat release rate during the FNK 11446 test was 12.1 kW/m² and the total heat release was 5.2 MJ/m².

BCA Part C, Clause C1.12 Non-combustible materials lists combustible materials that may be used wherever a non-combustible material is required. Plasterboard is one of the materials that may be used wherever a non-combustible material is required. Plasterboard will typically achieve a Group 1 as defined in Clause 4 of Specification C1.10 of the BCA. When tested in accordance with AS/NZS 3837 at 50 kW/m² irradiance in the horizontal orientation with an edge frame, Boral Enviro Multistop plasterboard achieves an average of 124.4 kW/m² peak heat release rate and 6.3 MJ/m² the total heat release, as documented in BRANZ Fire Test Report FH 4888.

The heat output for your "Dincel – Formwork" and "Dincel Sample A – Current Australian Use" Dincel extruded rigid PVC profile/concrete wall is less to that of typical plasterboard, a material deemed non-combustible in Clause C1.12 of the BCA, under the test conditions of AS/NZS 3837 at 50 kW/m² irradiance. The results of this fire test 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. "Dincel – Formwork" and "Dincel Sample A – Current Australian Use" did not ignite during the AS/NZS 3837 test and consequently the heat output values obtained during the test may not be representative of the heat the material contributes to a fire in more severe scenarios that result in the material igniting.

"Dincel – Formwork" and "Dincel Sample A – Current Australian Use" Dincel extruded rigid PVC profile/concrete wall system achieved an average specific extinction area of 90.5 m²/kg and 143.6 m²/kg respectively, as reported in CSIRO Test Report numbered FNK 0065 and FNK 11446. Boral Enviro Multistop plasterboard achieved an average specific extinction area of 34.1 m²/kg when tested to AS/NZS 3837:1998 at 50 kW/m² irradiance.

4 Conclusion

Based on the information presented in:

- Tests conducted in accordance with AS/NZS 3837:1998 at 50 kW/m² irradiance in the horizontal orientation with edge frame, and reported in CSIRO Test Report numbered FNK 11446 and Certificate of Assessment numbered 2215;
- Part A, Clause A1.1 Definitions of the National Construction Code Series, Volume 1, Building Code of Australia 2015 (BCA); and
- Part C, Clause C1.12 Non-combustible materials of the National Construction Code Series, Volume 1, Building Code of Australia 2015 (BCA),

Dincel Sample A – Current Australian Use" Dincel extruded rigid PVC profile/concrete wall has not been proven to be non-combustible as defined in the BCA, or to satisfy any criteria for materials that, though combustible or containing combustible fibres, may be used wherever a non-combustible material is required as defined in Part C1, Clause C1.12 of the BCA. Consequently, Dincel Sample A – Current Australian Use" Dincel extruded rigid PVC profile/concrete wall does not meet any of the Deemed-to-Satisfy criteria of materials that may be used wherever materials deemed non-combustible are required and this report does not assess the material to be non-combustible in accordance with the BCA DtS criteria.

The "Dincel Sample A – Current Australian Use" Dincel extruded rigid PVC profile/concrete wall, when tested in accordance with AS/NZS 3837:1998 at 50 kW/m² irradiance in the horizontal orientation with edge frame produces comparable or less heat output than some types of plasterboard, a material deemed to be non-combustible in Clause C1.12 of the BCA, and achieves an equivalent group number, as defined in Specification C1.10, Clause 4 of the BCA

The "Dincel Sample A – Current Australian Use" Dincel extruded rigid PVC profile/concrete wall, produces a greater average specific extinction area, a measure of smoke, than plasterboard when tested to AS/NZS 3837:1998 at 50 kW/m² irradiance. The average specific extinction area value measured was 143.6m²/kg which is less than the allowable smoke provision of 250 m²/kg in BCA Specification C1.10 (4)c(ii) for walls and ceiling linings in buildings not fitted with a sprinkler system.

The comparison in this report does not constitute an alternative solution.

5 Term of validity

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REFERENCE NO: 8 – 20 OCTOBER, 2016

References

The following informative documents are referred to in this Report:

ABCB	National Construction Code Series, Volume 1, Building Code of Australia 2015
AS/NZS 3837:1998	Australian/New Zealand Standard 3837, Method of test for heat and smoke release rates for materials and products using an oxygen consumption calorimeter, 1998 (Incorporating Amendment No. 1)
AS 1530.1-1994	Methods for fire tests on building materials, components and structures, Part 1- 1994: Combustibility Test for Materials.
AS 1530.4-2005	Methods for fire tests on building materials, components and structures Part 4: Fire-resistance tests of elements of building construction.
FNK11446	Fire test on "Dincel Sample A – Current Australian Use" Dincel extruded rigid PVC profile/concrete wall at 50 kW/m² irradiance in accordance with AS/NZS 3837:1998
FSV 1346	Fire test on a load-bearing, permanent polymer form, concrete wall system to Australian Standard 1530, Methods for fire tests on building materials, components and structures, Part 4-2005, Fire-resistance tests of elements of construction
FH 4888	BRANZ Fire Test Report FH 4888 to AS/NZS 3837 on Boral Enviro Multistop 13 mm thick paper faced plasterboard
	International Journal on Architectural Science, Volume 1, Number 2, p.96-107, 2000 The Impact of Wall Linings on Fire Hazard

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