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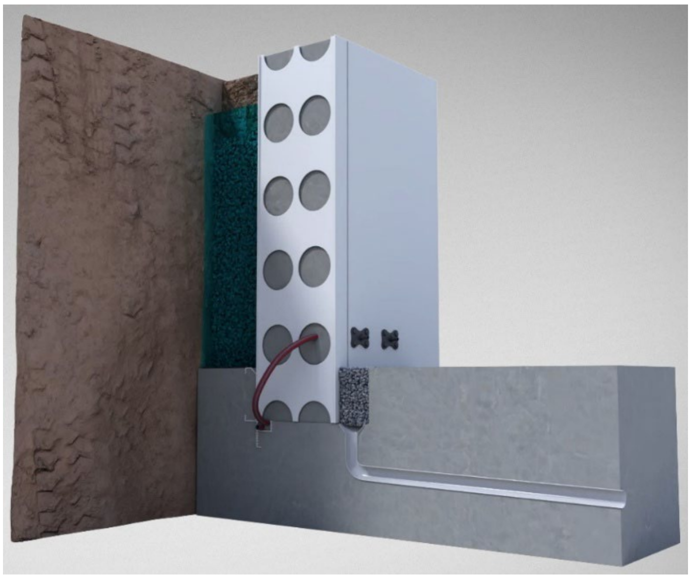
Expert Opinion -
Dincel Wall Water-tightness



Client: **Dincel Construction System Pty Ltd**

Project: **N/A**

Prepared By: **Mr. Sam Parker**

Privileged, confidential and prepared for the dominant purpose of legal proceedings

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Revisions

Revision	Description	Date	Prepared by	Approved by	Signature
00	Final	13.04.26	S.Parker	S Parker	
01	Final – minor amendments sections A and F.	14.04.26	S.Parker	S Parker	
02	Final – update to reflect NCC2025.	27.06.26	S.Parker	S Parker	
03	Final – Corrected warranty version number.	06.07.26	S.Parker	S Parker	Sam Parker

Review Panel

Division/ office	Name
Melbourne	L. Cervenjak

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A. Executive Summary

1. Dincel Construction System Pty Ltd uses an innovative way of waterproofing basement walls through their patented wall panels and accessories (warranted Dincel Construction System).
2. Dincel Construction System Pty Ltd have undertaken extensive independent testing on their walling system, which has resulted in them having sufficient confidence to offer a waterproofing warranty to their clients.
3. I have reviewed their relevant test reports, scrutinised the terms and conditions associated with their warranty and have inspected test panels and test tanks associated with the aforementioned test reports.
4. It is my opinion that:
   - The warranted Dincel Construction System basement wall can prevent *sub-surface water*, *rising damp* and *surface water seepage**, which would otherwise penetrate through a below-ground wall, from causing undue dampness or deterioration of building elements, unhealthy or dangerous conditions, loss of amenity for building occupants, or damage or nuisance to other buildings or property.
   - The warranted Dincel Construction System can produce a basement wall which performs to Grade 2, in accordance with BS 8102. [Grade 2 performance does not permit any seepage. Furthermore, it does not permit damp areas on the inside of the structure caused by external water entry, but it does not consider dampness/condensation on the exposed inner dry wall surface caused if the dew point is reached.]
   - If a suitable inner-skin dry-wall is constructed beyond the Dincel Construction System wall and perimeter dish drain, and/or if appropriate dehumidification and/or air conditioning forms part of the overall building design, then the warranted Dincel Construction System can produce a basement wall which performs to Grade 3 in accordance with BS 8102. [Grade 3 performance does not permit any seepage. Furthermore, it does not permit damp areas on the inside of the structure caused by external water entry or dampness/condensation from internal moisture sources.]
   - In context of below-ground walls, the warranted Dincel Construction System wall is capable of satisfying clause F1P1 in NCC 2025, Volume 1
5. The endorsement is valid under proviso that the basement is constructed within the limitations described in this report and the Dincel Construction Manual Waterproofing Addendum (version 15.2026).
6. The endorsement does not extend to the performance of the slab-on-ground (floor of the basement), nor the roof of the basement. That is, the endorsement is specific to the performance of the walls and assumes the basement floor and roof is watertight.

Refer to NCC 2025, Volume 1 Definitions for sub-surface water, rising damp and surface water seepage

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B. Introduction

B.1 General

7. This report has been prepared on behalf of Dincel Construction System Pty Ltd (**Dincel**).

8. The joint between an insitu poured below-ground slab and perimeter below-ground wall can often lead to water ingress. Dincel has developed an innovative product, system and process that is said to provide a water-tight seal between a Dincel wall and an adjacent insitu poured slab.

9. This report aims to provide an independent expert opinion on the conclusions that can be drawn from the results of Dincel's test programs and the representations Dincel currently make as to the waterproof qualities of the Dincel wall.

B.2 Report Limitations

10. The scope of this report is limited to Class 2 to 9 structures captured in Volume 1 of NCC 2025.

11. I have previously authored an identical report which captured the waterproofing requirements in Volumes 1 and 2 of NCC 2022.

12. I note that there has been no material change to Section H of Volume 2, NCC 2025 compared to NCC 2022, Volume 2 and so no new opinion is expressed in this report with respect to Classes 1 and 10.

13. Refer to my earlier report where an opinion with respect to the waterproofing requirements under NCC 2022 is relevant, or where Section H of Volume 2, NCC 2025 is relevant.

14. In formulating my opinions, I have relied upon the accuracy of information presented in various test reports prepared by independent regulatory authorities, testing laboratories, relevant subject matter experts and the like. Where such reliance has been made, I list the document reference.

15. In February 2023, I had the opportunity to attend Dincel's test yard facility in Kemps Creek, Sydney, NSW. Some of my opinions have been influenced by visual inspection of Dincel test tanks referenced in the aforementioned test reports. I did not undertake any destructive testing during my inspection.

16. I reserve the right to amend information and opinions presented in this report if more information becomes available to me or if any conditions upon which my opinions have been formulated materially change.

17. Unless express dispensation has been afforded by Acor Consultants Pty Ltd (**ACOR**), this report should not be reproduced except in its entirety.

18. Any opinions expressed in this report has been done under privilege of the Evidence Act 1995.

19. Any party outside of Dincel should undertake their own due diligence on the matters raised in this report.

B.3 About the Author

20. I have been in the construction industry for over 34 years and hold two engineering degrees (civil engineering and structural engineering). I am an Executive Director, Service Leader and Senior Principal in the field of remedial engineering and waterproofing for ACOR.

21. I am a Fellow of the IEAust, an Associate of the Australian Society of Building Consultants, a member of the Concrete Institute of Australia, a member of the Master Builders Association of Australia, a member of the Australasian Concrete Repair & Remedial Building Association and I am a Registered Design Practitioner.

22. I have held senior positions, such as Operations Manager and Managing Director of leading remedial contracting companies who specialised in the assessment and rectification of non-compliant structures, particularly in concrete repair and waterproofing.

23. I am a sitting member of technical committee – BD-038 (formerly BD-038 and BD-013) for Standards Australia. BD-038 is the committee responsible for authoring the following waterproofing Standards for Standards Australia: AS3740, AS4858, AS4654.1 and AS4654.2.

24. I am a sitting member of technical committee – BD-113 Integrated Moisture Protection for Buildings for Standards Australia. BD-113 is the committee responsible for preparing a code of practice and Standard for below ground structures.

25. I am a sitting review panel member of Section F – Health and Amenity of the BCA for the Australian Building Codes Board (ABCB). Section F of the BCA is predominantly related to waterproofing and weatherproofing of structures.

26. I am a co-author of the waterproofing training course for the Australasian Concrete Repair & Remedial Building Association. I am also a course trainer in NSW for the Association.

27. I regularly present for recognised industry bodies such as the Australian Institute of Waterproofing, Australasian Concrete Repair & Remedial Building Association, the Australian Society of Building Consultants, and the Concrete Institute of Australia in the field of waterproofing.

28. I have been published on various building issues and construction techniques, particularly so in relation to waterproofing and corrosion related matters. I continue to be commissioned by various clients as an expert in building and construction throughout Australasia.

29. I act as a principal waterproofing consultant for government on projects of Federal and/or State significance. I also act as principal waterproofing consultant for major international and national Tier 1 and Tier 2 contractors.

30. I have won awards via the Master Builders Association, Australasian Concrete Repair & Remedial Building Association and Parks and Leisure Association for my work over the years and I currently spend most of my time consulting in waterproofing, corrosion and general building defect related matters.

C. Background to Waterproofing of Basements

C.1 Relevant Legislative Requirements

31. In NCC 2025, Volume 1, the waterproofing performance requirements for external-above-ground and below-ground structures are clearly described in clause F1P1*.

**Exemptions exist for private garages, tool sheds, sanitary compartments or the like separate from, or forming part of a building used for other purposes, and open spectators stand or open-deck carparks*

32. Broadly speaking, F1P1 is split into 4 sub-clauses (F1P1(1) through to F1P1(4)) and requires that water management around or in the structure be capable of preventing:

- unhealthy or unsafe conditions for occupants
- undue damage to internal surfaces and building elements
- loss of amenity for building occupants
- undue damage or nuisance to other buildings and property

33. Notwithstanding the performance requirements in NCC 2025, Australia does not currently have a Standard, Code of Practice or Handbook related to waterproofing of water-resisting below-ground structures.

34. There are, however, Australian Standards which relate to waterproofing or watertightness of other types of structures/building elements. These are listed below, but none of them expressly relate to basement structures.

- AS/NZS 3740 – Waterproofing of Domestic Wet Areas
- AS/NZS 4654.2 - Waterproofing Membrane Systems for Exterior Use - Above Ground Level - Design and Installation
- AS/NZS 3735 – Concrete Structures for Retaining Liquids
- AS/NZS 4858 – Wet Area Membranes
- AS/NZS 4654.1 - Waterproofing Membranes for Above-Ground Use - Materials

35. Whilst each of the above Standards contain elements which can be relevant (by way of analogy) to basement waterproofing: material selection, design and installation, none can be relied upon to develop a holistic solution.

36. It is common for designers and specifiers in Australia to seek guidance from long established European Standards, such as BS EN 3: Eurocode 2 – Design of Concrete Structures – Part 3: Liquid Retaining and Containment Structures and/or BS 8102: Code of Practice for Protection of Below Ground Structures Against Water from the Ground. Eurocode 2 is related to structures which are designed to retain water rather than exclude water. Nevertheless, it has traditionally been used as a waterproofing design guide. Eurocode 2 considers only the design of reinforced concrete and does not explore other methods of protection, including the use of ‘waterproof’ additives or admixtures to the concrete.

37. BS 8102 is, in our opinion, the most widely adopted guidance document used in Australia for the waterproofing of below-ground structures. The current version of BS 8102 is 2022. The British Standard is not a design Standard comparable, say to AS 3735 or BS EN 3:2, but it does nevertheless provide guidance on how to achieve adequate protection using three different types of waterproofing techniques. The document advocates a risk-based approach to determining the recommended level of protection.

38. Australia is in the process of preparing its own Standard for below-ground structures. It will predominantly follow the BS 8102 design approach.

C.2 Traditional Waterproofing Techniques

39. BS 8102 differentiates waterproofing barriers into 3 different “Types”, simply termed Types A, B and C. It is possible to partially, and in some cases completely, waterproof a basement structure with any of these systems, each having its pros and cons. It is important to note that

the Type of system which is most suitable for a project is related to the level of waterproofing performance required.

40. Waterproofing of basement structures is predominantly, but not solely, undertaken on the blind-side of the structure by placing a bonded or un-bonded sheet membrane on top of the ground stratum prior to placing concrete on top of and beside the membrane. The idea is that the waterproof sheets create a barrier between the concrete structure being protected and permanent and/or temporary water build-up in the ground. This type of system is called a Type A barrier (refer to Fig 1).

41. Type A barriers can also be placed on the negative hydrostatic pressure side of a structure, but this method is rare as the steel reinforcement in concrete structures do not get the benefit of being protected against the damaging effects of prolonged exposure to water and potentially dissolved corrosive pollutants.

42. The level of watertightness achieved in a structure containing a Type A system primarily depends on the effectiveness of the waterproofing system. That is, it assumes that the structure will not contribute to watertightness, unless it is forced to do so because of failure in the Type A barrier.

43. Building materials that are less permeable (for example, well compacted concrete walls) and which resist or lessen the flow of water can extend the applicability of Type A barriers. It is for this reason that high performance concrete is often incorporated as part of the overall waterproofing strategy for significant (or important) structures.

44. Where a permanent or temporary intersecting water table exists (or forms), any defects in the waterproofing barrier are likely to allow water to penetrate the structure. If building materials within the structure are permeable (for example, honey combed or otherwise porous concrete) then water will tend to enter the basement, and if not then removed, the basement may fill to significant levels.

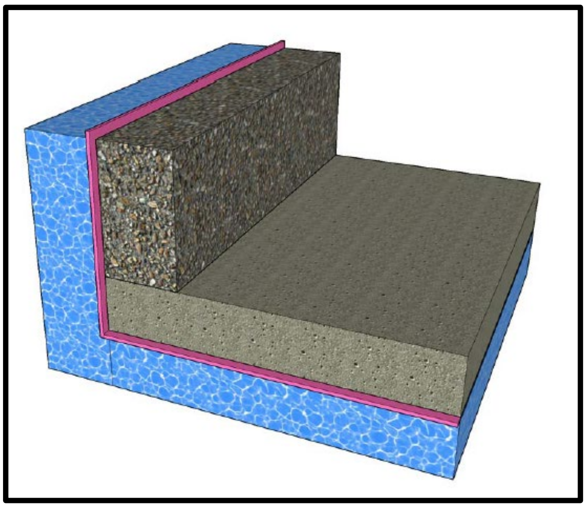

Fig. 1 – Type A Barrier System (pink shading represents waterproofing element)

45. Type B systems are essentially structurally integral barriers. That is, the watertightness of a structure which contains a Type B system assumes that the structure itself is impermeable. Chemical additives are usually added to the un-hardened concrete mix to produce low-permeability, low-shrinkage concrete. It is typically supplemented with appropriate joint detailing (refer to Fig 2).

46. The additives can also aid in promoting autogenous healing of fine non-flexural cracks. However, if the ground water is contaminated and/or is under high pressure then fine cracks may not seal.

47. The success of Type B systems is proportionally related to the quality of concrete and the amount of care taken in placing it. Small cracks, less than a fifth of a millimetre (200 microns), can become pathways for ground water to travel and spread.

48. The most common cause of waterproofing breaches in Type B systems include poor concrete quality, excessive movement at joints, and cracking. Therefore, special attention needs to be paid to joints and the positioning of water stops. In addition, great care is required when placing and compacting the concrete.

49. Controlling water ingress at construction joints is usually achieved by incorporating a dendritic, hydrophilic or hydrophobic system that reacts in the presence of water to seal the joint.

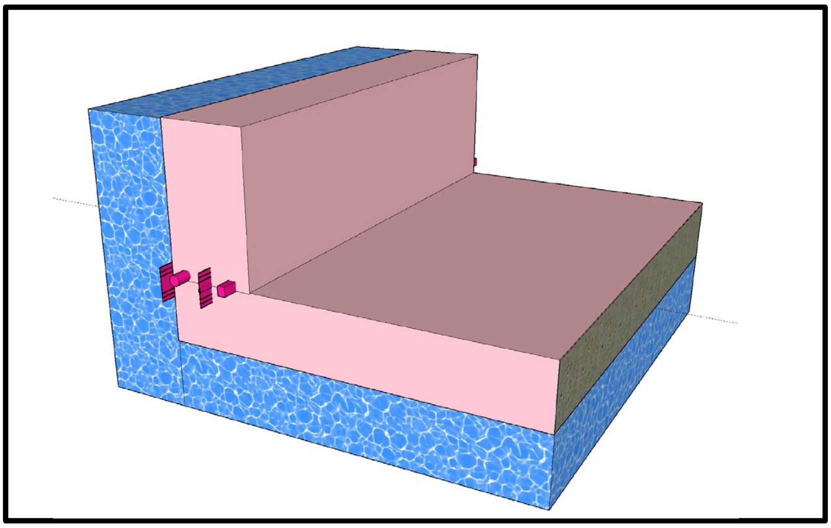

Fig. 2 *– Type B Barrier System* (pink shading represents waterproofing element)

50. Type C systems assume that water will enter the structure and aims to manage the ingress so that it does not manifest on faux (finished) surfaces. Type C systems rely firstly on water being resisted by the concrete structural elements, and where ingress does occur, it collects it in a formed cavity between the external wall and a "faux" internal lining/wall (refer to Fig 3).

51. There is permanent reliance on the cavity to collect ground water seepage and direct it to suitable discharge points. The amount of water entering the cavity will depend on the volume of external water, its hydrostatic pressure, and on the resistance of the structure itself to water ingress.

52. Type C systems typically remove water via a mechanical pump system, or occasionally by gravity to lower ground.

53. Type C pumped systems are typically engineered to cope with worst-case water ingress so that the drainage capacity is never exceeded.

54. Basement waterproofing system, particularly those below the water table. Are rarely 100% reliable. Where a structure is exposed to permanent, or transitory hydrostatic pressures, even local failures in the waterproofing can create widespread infiltration. Therefore, a robust waterproofing solution will often utilise a combination of Types A, B and C systems to build redundancy into the design.

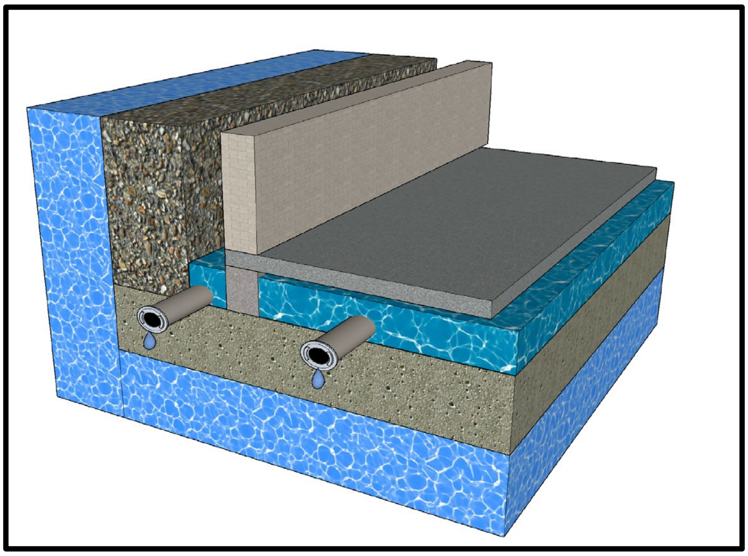

Fig. 3 – Type C Barrier System

C.3 Water-tightness Performance Grades

55. Water has an affinity to seep through cracks and joints and other defects in concrete.

56. Industry experience and building science literature indicate that a substantial proportion (commonly reported as 50% or more) of basements and below-ground structures, particularly those constructed below the prevailing groundwater table, experience some form of water ingress during their service life, even where compliant systems are installed*.

57. In fact, anecdotal evidence collected by various researchers suggests that half of all basements leak at some point during their construction and that a lesser, but still significant, proportion will sporadically leak post-construction. The asset owner should therefore anticipate that maintenance of random leaks will be required from time-to-time over the life of the structure.

58. One may ask, "why is sub-structure leakage so common?" The simple answer to that question is that in below-water-table construction, the groundwater is under pressure and will therefore have sufficient potential energy to flow through any weaknesses in the structure via paths of least resistance (for example, through cracks in the substructure). Furthermore, sub-structures cannot entirely be constructed monolithically and will contain construction joints, which can act as water pathways.

59. Where there is potential for perched water tables to form (for example, after unfavourable inclement weather or harsh seasonal conditions) temporary hydrostatic pressures can develop, causing water ingress. Leaks are more common in sites that are sloping and/or where there is no drainage zone between the structure and the ground.

**NAHB – moisture prevalence in basements; BS 8102 / Concrete Society – inevitability of cracking and ingress; Building Science Corporation – below-water-table risk and limitations; Aviva Insurance / latent defect guidance*

60. Waterproofing performance Grades, as described in BS 8102 (and other international Standards), are qualitative rather than quantitative. Qualitative (or performance) based descriptions can lead to more than one interpretation.

61. In practise, defining the level of substructure water resistance goes beyond simply stating that the structure needs to be "dry" or "water-tight" or that "wet-walls are acceptable". It is critical that project stakeholders understand and agree on what the performance expectations are for the basement waterproofing.

62. Fig 4 contains an extract of Table 2 of BS 8102 (2022). One can see that the Standard adopts qualitative ways to describe the level of water-tightness.

Table 2 — *Waterproofing protection – Grades of performance for below ground spaces*

Grade[A)]	Performance definition
1a	Seepage[B)] and damp areas[C)] from internal and external sources are tolerable, where this does not impact on the proposed use of below ground structure. Internal drainage might be necessary to deal with seepage.
1b	No seepage[B)]. Damp areas[C)] from internal and external sources are tolerable.
2	No seepage[B)] is acceptable. Damp areas[C)] as a result of internal air moisture/condensation are tolerable; measures might be required to manage water vapour/condensation[D)].
3	No water ingress or damp areas[C)] is acceptable. Ventilation, dehumidification or air conditioning necessary; appropriate to the intended use[D), E)].

A) The agreed grade should meet with the client's expectations for the intended use of the below ground space. Reducing the grade could increase the risk of not meeting the expectations of the client for the intended use of the below ground space.

B) Seepage (sometimes referred to as weeping) is defined in 3.15. If there is seepage, there is a possibility of mineral deposits forming.

C) Damp area is defined in 3.4.

D) The scope of this document is limited to detailing the process and best practices that can be followed when creating a waterproof or water-resistant structure below ground. The additional considerations that are required to achieve the required environment are beyond the scope of this document.

E) See BS 5454 for recommendations for the storage and exhibition of archival documents.

Fig 4. Performance Grade profile *(image extracted from BS8102)*

63. To better illustrate the idea of 'Grades', Fig 5 below shows how moisture tolerance can fit in with the idea of a sliding-scale of water-resistance. The figure is indicative only and serves to aid understanding, rather than provide a definition of the 'Grades'.

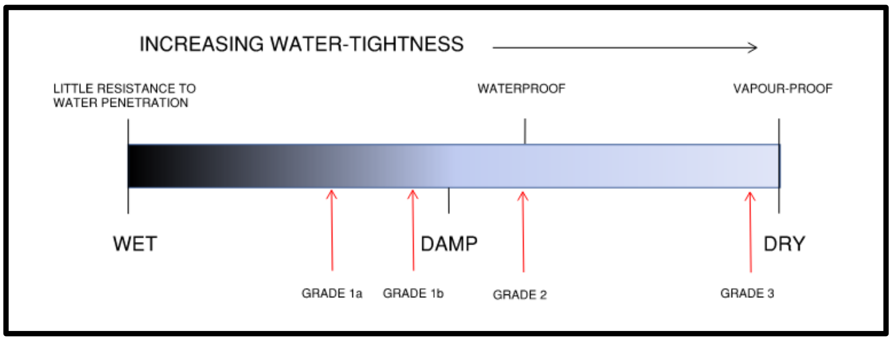

Fig 5 – Sliding Scale Reflection of Waterproofing Grades

64. Grade 1a performance permits seepage and dampness.

65. Grade 1b performance allows dampness, but not seepage.

66. Grade 2 performance does not permit any seepage. Furthermore, it does not permit damp areas on the inside of the structure caused from external water entry. Dampness due to condensation is acceptable, however.

67. Grade 3 performance, the most stringent waterproofing performance level, requires the waterproofing system to include management of the internal air temperatures and relative humidities. Seepage, dampness, and condensation on inner exposed surfaces is not permitted.

68. It is noteworthy to mention that several materials used in basement waterproofing (such as dendritics, hydrophobics and hydrophilics) contain dynamic ingredients that require exposure to moisture for it to perform. In instances where exposure to water may be sporadically restricted (due to events such as droughts, dewatering, artificial decreases in local water table levels, etc), it can have the effect of passivating those materials temporarily or even diminishing the efficacy of those materials in the long term. A usual side effect of this phenomenon is that water will enter the site temporarily (a few days to some months typically) until such time that those materials once re-activate.

C.4 About the Dincel System

69. Dincel Construction System (**DCS**) is a permanent polymer formwork system for concrete walling. It is generally used to construct a wide range of concrete walls including basement walls.

70. The predominant feature of DCS is that the formwork is constructed segmentally by sliding adjacent panels into a patented snap interlocking system (refer to Fig 6).

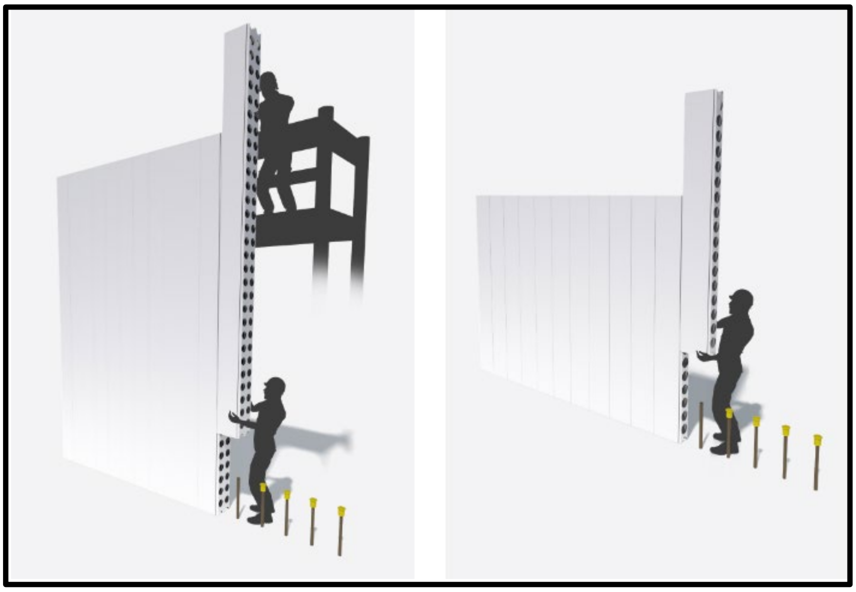

Fig 6. Segmental Construction of DCS *(image extracted from Dincel literature)*

71. The polymer formwork stays in place after the concrete is poured, thereby providing the wall with a durable skin cable of restricting water ingress. When used in conjunction with supplementary waterproofing techniques at joints, the DCS is intended to function as an alternative to the previously described traditional waterproofing techniques.

72. The DCS can be constructed using different widths, being 110mm, 155mm, 200mm and 275mm. The 110mm panels are not used for external basement wall scenarios. The images in Fig 7 below show the profiles for each of these sizes. The plan view of the 275mm panel is

also displayed to show how its internal webbing differs from the 155mm and 200mm panel types.

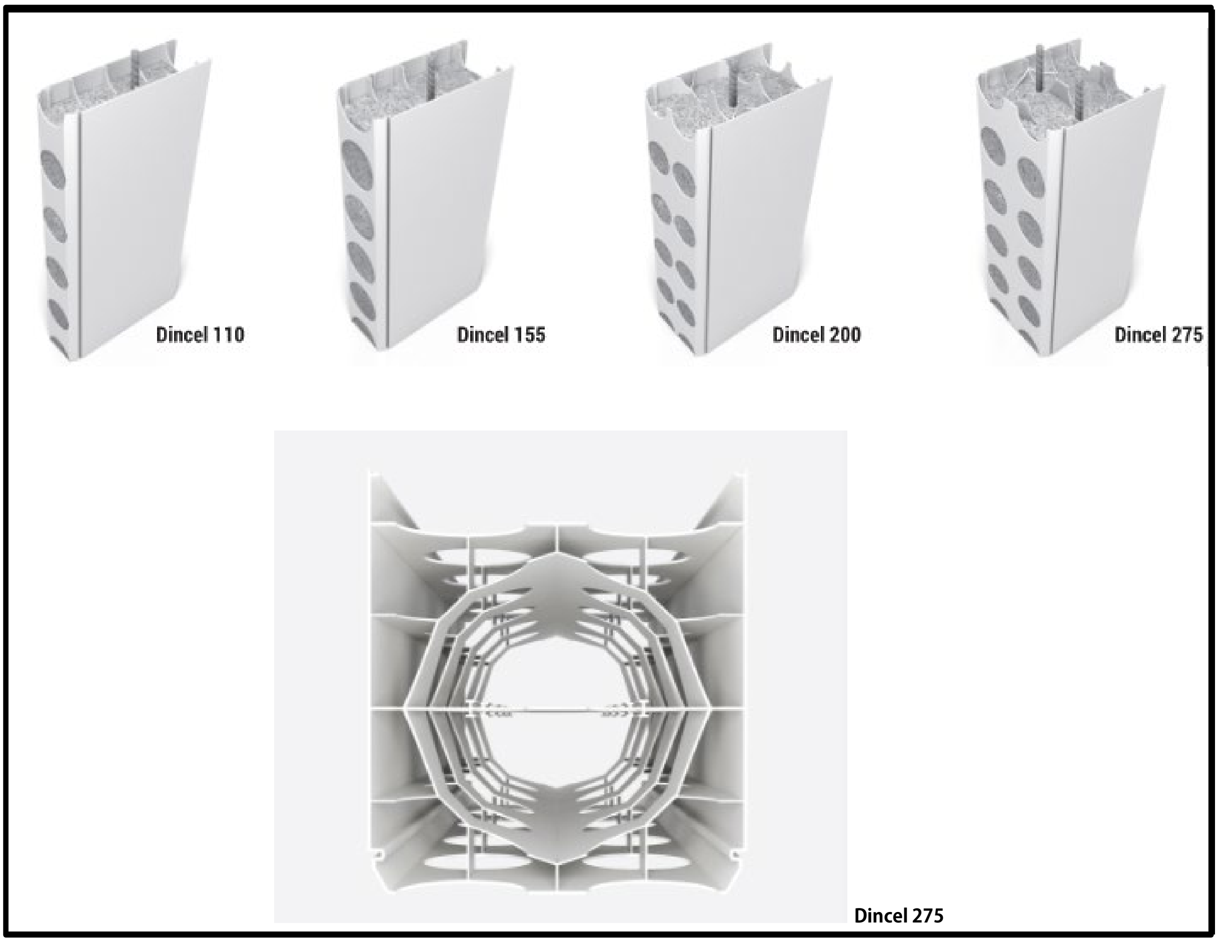

Fig 7. DCS Profiles *(image extracted from Dincel literature)*

73. At the connection of the DCS and the footing and/or slab-on-ground, a patented water stop (**Dincel water stop**) is inserted to provide waterproofing protection at that location. An image of the Dincel water stop is shown in Fig 8 below. More discussion on how the Dincel water stop mitigates the risk of water entry at the wall to slab and/or wall to footing joint is provided further into this report.

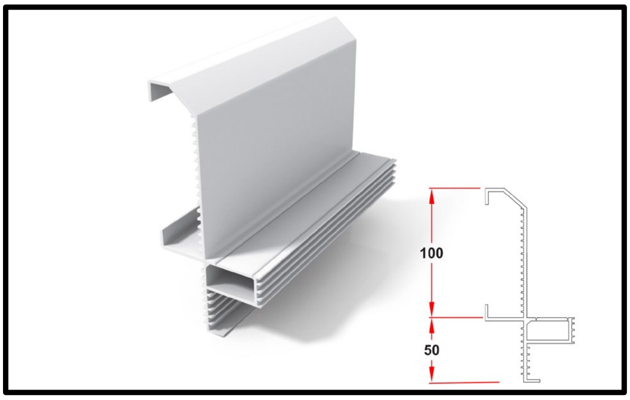

Fig 8. Dincel water stop *(image extracted from Dincel literature)*

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C.5 The Waterproofing Claim by Dincel

74. In relation to basement walls, and subject to specific terms and conditions, Dincel warrant that their products will, for a minimum of 10 years, satisfy the below-ground waterproofing requirements of:

- Clause F1P1 in Volume 1 (Classes 2 to 9 Structures), NCC 2025
- ASTM E 96/M 96M-05 (Standard Test Method for Water Vapour Transmission of Materials)
- AS3735-2001, Clause 7.3 for liquid tightness of water retaining Structures.

75. Waterproofing of the slab-on-ground is not included as part of their claim or warranty.

76. At the expiry of the warranty period, Dincel may, under separate terms and conditions, allow extension of the warranty period by 10 years. Dincel say that warranty extensions may continue at each 10-year anniversary up to a maximum of 4 cycles, thereby resulting in a maximum possible warranty period of 50 years.

77. The relevant terms and conditions related to their 10-year warranty can be summarized below. I have included only those terms and conditions which are relevant to my discussion. The reader is encouraged to consult with Dincel to obtain a full list of their terms and conditions.

- The maximum expected relative level of the permanent and/or temporary ground water tables (**GWT**), over the warrantable period, must be determined by others
- Any warrantable design must be vetted and formally approved by Dincel
- The shop-drawings prepared by Dincel must be incorporated into the project
- Installation of the DCS must be undertaken by a Dincel nominated and endorsed installer
- The Builder must incorporate into its own HSQE system, inspection test plans (ITP's), which are to be approved Dincel. The Builder's ITPs are to be based on the Dincel generic ITP templates which are related to the walls
- Dincel must be present and oversee key aspects of the wall build to release Hold Points
- The plan geometry of DCS must be a complete loop so that the basement takes a tank-like form factor. It must not contain any curved sections of wall, nor be a free-standing retaining wall
- The DCS must extend at least 500mm above the GWT
- The basement must include a functioning dish drain around its perimeter, which should be formed by a monolithic hob or set-down in the concrete slab-on-ground. The dish drain must include properly set-out drainage pits and include pump-out facility
- The DCS must include the Dincel water stop and re-injectable hose
- The core fill material must be self-compacting concrete (**SCC**) as detailed in Dincel Construction Manual Waterproofing Addendum *(version 15.2026)* (**DCMWA**) and result in voidless concrete
- The re-injectable hose in the wall to slab-on-ground and/or wall to footing joint must be injected by Dincel using their nominated hydrophobic resin after the completion of: building structural works; dewatering; wall backfilling and at least thirty days after the wall has been filled with SCC

- Any adjoining DCS which does not incorporate the patented snap interlock joint and/or any non-perpendicular corners to the basement must be waterproofed by a Dincel endorsed installer using Dincel nominated and NCC compliant waterproofing bandage
- Where the DCS is exposed to a permanent, perched or temporary GWT, the DCS must be devoid of penetrations to a height of at least 500mm above the GWT
- Where the DCS is not exposed to a GWT, the DCS must be devoid of penetrations to a height of at least 500mm above the footing slab junction
- The DCS must be free of horizontal panel-to-panel butt joints, at least to a point 500mm above the GWT
- Intersecting internal wall and or lift pit wall junctions should be connected via dowels and penetrate the internal (dry side) of the DCS only
- Suspended slabs which are lower than 500mm above the GWT must be connected to the DCS via dowels and penetrate the internal (dry side) of the DCS only. That is, the DCS panels must be vertically uninterrupted by intermediate slabs
- The DCS must not be exposed to traffic/backfilling compaction and/or other surcharge loading greater than a combined 10kPa pressure unless the maximum lateral deflection at any point on the wall is limited to not greater than 1mm by the structural design (refer to Section D.4 of this report)
- The structural engineer for the project must comply with design requirements of the Dincel Construction Manual and the DCMWA
- The maximum GWT which the DCS is exposed to must not exceed that stipulated in Tables G1.1 and G1.2 of the DCMWA. Refer to Fig 9 below
- The slab-on-ground must be appropriately waterproofed by others

G.1.1. ONE WAY SPANNING WALLS BETWEEN BASEMENT SLABS

WALL THICKNESS	MAXIMUM STRUCTURAL HEIGHT BETWEEN SUPPORTS (M)*	MAXIMUM ALLOWABLE GROUND WATER HEIGHT (M) # ABOVE THE WALL-FOOTING JUNCTION
155 DINCEL	3.0 and lower	0.4
200 DINCEL	4.0	NIL
	3.6	0.4
	3.3	0.8
	3.0 and lower	1.0
275 DINCEL	4.5	1.5
	4.0	2.5
	3.5 and lower	3.5

G.1.2. TWO WAY SPANNING WALLS BETWEEN BASEMENT SLABS AND BUTTRESSES

WALL THICKNESS	MAXIMUM STRUCTURAL HEIGHT BETWEEN SUPPORTS (M)*	MAXIMUM ALLOWABLE GROUND WATER HEIGHT (M) # ABOVE THE WALL-FOOTING JUNCTION
275 DINCEL	5.0	2.0**
	4.5	3.5**
	4.0	4.0**

* **NOTE:** Represents the structural height for the basement wall between the lateral supports provided by the footing-slab and suspended slabs over.

** **NOTE:** Maximum space between buttresses supporting two way spanning basement wall is 3.0m. This is to suit any carparking spaced between 2.4m and up to 3m. The length, height, thickness of the buttress walls is to be determined by the Structural Design Engineer. Buttresses can only be placed at the inside face of the basement wall which is opposite to the earth and/or water. The connection between the perimeter basement wall and buttress walls shall only be a single galvanized dowel bar to the center of the buttress wall and away from any Dincel panel joint.

NOTE: Ground Water Table Position (water table ▼) means the highest potential ground water position which includes permanent (purged water table), tidal water position due to sea/river level movement and storm water movement above each relevant wall-footing slab junction for the period of warranty.

Fig 9. Maximum permissible GWT *(image extracted from the Dincel Construction Manual Waterproofing Addendum (version 15.2026))*

D. Opinion

D.1 General

78. Dincel claim that their DCS, when designed and installed under specific conditions, will result in a waterproof wall. Furthermore, that it will comply with the clause F1P1 of NCC 2025 related to “Managing rainwater impact on the building and adjoining properties”.

79. Their literature defines, via a combination of qualitative and quantitative means, what they consider to be waterproof. Their definition of “waterproof” can be found in Fig 10 below. I have also collated the definitions of cross-referenced terms for ease of comprehension.

> **Waterproof** means:
> (a) For habitable underground spaces: No evidence of Beading of Water on the inner dry wall (installed by others) and no evidence of a Damp Patch.
> (b) For non-habitable underground spaces: No evidence of Weeping of Water on the wall or in the dish drain (beading of water is permitted) and no individual Damp Patch on the wall or in the dish drain which has an area greater than 0.1m2 (equivalent in area to an A3 sheet of paper) on the wall or in the dish drain, for any 5m length of wall.
>
> **Beading Of Water** is the state in which individual droplets of water (held by surface tension effects) form on the wall and adhere to the wall. The water beads do not coalesce with each other. The beads remain stationary and do not flow.
>
> **Damp Patch** means when touched, a damp patch may leave a slight film of moisture on the hand, but no droplets of water or greater degree of wetness are left on the hand. On a concrete surface a damp patch is discernible from a darkening of the colour of the concrete.
>
> **Weeping Of Water** is the state in which droplets of water form on the surface of the wall and coalesce with other droplets. The coalesced water does not remain stationary on the wall surface, but instead flows down the wall.

Fig 10. Dincel definition of “waterproof” *(image extracted from Dincel literature)*

80. The above definitions appear to be derived from the widely accepted UK source document *Specification for Piling and Embedded Retaining Walls*, prepared by the UK Institute of Civil Engineers. I believe the definitions to be in line with general industry expectations.

81. I have previously mentioned in this report that there is currently no Australian Standard related to the waterproofing design and installation of below-ground water resisting structures, resulting in Australia having to adopt existing international Standards, the most common of which is the British Standard, BS 8102.

82. It appears that the Dincel definition of “waterproof” best matches BS 8102 performance Grades 3 and Grade 2 for habitable and non-habitable areas, respectively (refer to Fig 4).

83. Is such a claim by Dincel justifiable? To answer that we need to consider the usual causes of water entry through basement walls and assess how the DCS, in conjunction with the Dincel warranty terms and conditions, mitigates risk.

84. Poor quality control procedures during installation and/or poor design are usually the cause of failures.

85. In a below-ground scenario, waterproofing failures most commonly occur at and/or because of:

- Joints (expansion, construction, etc)

- Concrete defects (honey combing, excessive shrinkage, thermal movement, creep, tensile cracking)
- Service penetrations through waterproofing
- Low concrete permeability

D.2 Joints

86. Dincel do not permit horizontal joints which are lower than 500mm above the GWT. An obvious exception is the main construction joint which exists between the slab-on-ground and the base of the wall.

87. The warranted DCS mitigates the risk of water entry at this location by placing a primary and secondary protection barrier in place at the joint. Furthermore, the system is made more robust by the inclusion of two redundancies: (i) a renewable secondary barrier (re-injectable hose); and (ii) a functional perimeter dish drain on the inside face of the wall.

88. The joint treatment is shown diagrammatically in Fig 11 below.

89. The primary barrier takes the form of Dincel's patented Dincel water stop (refer to Fig 8). Essentially, the Dincel water stop is a water stop which uses the principal of tortuous path resistance. That is, profiles with complex cross sections have a much greater surface area, thereby presenting a much greater resistance and more difficult path for water to traverse.

90. The Dincel water stop has several changes in direction and contains crenellations on the vertical surfaces which come in contact with the concrete, similar to those found in more conventional sheet membrane central or rear-guard water bars. Tortuous path resistance is a recognised waterproofing technique used in BS 8102 Type B barriers (refer to Section C.2). The Dincel water stop is therefore likely to be effective in preventing or minimising water entry at the subject joint.

91. If some water does find its way past the Dincel water stop, the secondary barrier placed at the base of the wall, and within the Dincel water stop, would take effect. The secondary barrier is a pre-installed re-injectable hose capable of allowing the transfer of waterproofing resins through the hose. When sufficient pressure is built up within the hose, the resin is forced into the construction joint, filling micro voids and cracks, and thereby blocking the passage of water.

92. Like the Dincel water stop, the re-injectable hose and waterproofing resin is a recognised waterproofing technique used in BS 8102 Type B barriers. The re-injectable hose and waterproofing resin is therefore likely to be effective in preventing or minimising water entry at the subject joint.

93. The resin being injected should be hydrophobic in nature rather than hydrophilic so that the hoses are capable of being re-injected, if required. That is, if a sufficiently low viscosity hydrophobic resin is used to inject the hoses, and subject to the hoses being cleaned out after each injection event, the hoses can act as a perpetual form of contingency within the waterproofing system.

94. In construction, things can and do go wrong, despite best laid plans. The subject joint is therefore protected by a tertiary contingency water management barrier. This barrier takes the form of a functional perimeter dish drain. So, if water does by-pass the primary and secondary barriers temporarily, it is directed, collected and drained away rather than being allowed to manifest on the slab surface inside the basement structure.

95. The use of dish drains falls into the Type C waterproofing category according to BS8102.

96. I consider that the multiple layers of redundancy and contingency systems placed at the slab-on-ground to wall joint results in a robust and effective means of waterproofing.

A - Dincel Wall.

B - Steel reinforcement to engineers' details.

C - Starter bars, tied to footing by either casting in or postfixing (drill & epoxy) as per engineer's detail.

D - Concrete footing slab to engineer's details.

E - Dincel Water Stop (DWS) used as cast-in shutter to form hob.

F - Re-injectable hose system to provide waterproofing injection material.

G - Min 100mm.

H - Min 100mm set down. Timber can be used to form rebate and also as temporary restraint.

I - Min 300mm and to project engineers specifications.

J - Dish drain to project engineer's details.

K - Drainage system by others.

L - Concrete fines/sand/backfill to engineer's details.

M - Shoring by others.

N - If required, nominated membrane or equivalent by others.

O - Dincel nominated waterproofing bandage over lapping nominated membrane on DWS if nominated membrane under slab is used.

NOTE: Self Compacting Concrete (SCC) and injection material MUST be used with the following detail.

NOTE: No accessories (such as guide P-G) to be used underneath wall.

NOTE: Waterproofing footing/slab by others.

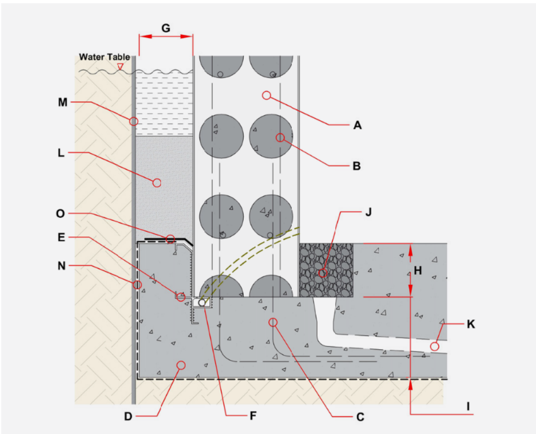

Fig 11. Slab to wall joint treatment *(image extracted from Dincel literature)*

D.3 Concrete Defects

D.3.1 Concrete Density

97. Let us now consider how the warranted DCS mitigates the risk of water entry that typically occur because of concrete defects such as honey combing, and/or cracks caused by thermal movement, flexure, excessive shrinkage and creep. Note: the potential risk of water entry through penetrations is not discussed since Dincel do not permit penetrations (up to a height 0.5m above the GWT) in warranted walls. Furthermore, it is assumed that any penetrations above that height will be specifically waterproofed by others.

98. Dincel require that the infill material for the wall be SCC. The concrete is required to have a spread of 680mm, which correlates roughly to a slump of 285mm. It must be agitated in the top 400mm of each concrete lift and must be placed via a concrete pump hose, or similar at no more than 4m centres. The concrete placement must be initiated at wall corners to facilitate a consolidated/compacted flow of the wet concrete.

99. For basements under hydrostatic pressure, Dincel requires the use of the 200mm and/or 275mm wide profile. The 275mm profile contains an internal circumferential webbing system to promote easy flow of the SCC (refer to Fig 7).

100. Dincel have undertaken investigation on test panels to determine whether SCC can produce void-free concrete. Dincel had the testing supervised by well-respected concrete material scientists, Mahaffey Associates.

101. Mahaffey Associates found that the test panels were free of any voids (save a localised superficial void), including around reinforcement bars and in corners. They concluded that the possible risk of voids being present in the concrete can be adequately addressed with the use of SCC. I understand that Dincel have web links available to the public to access the full Mahaffey report.

102. I had the opportunity to inspect the test panels and was able to satisfy myself that the concrete was free of voids (refer to Fig 12).

Fig 12. SCC concrete free of voids *(image extracted from Dincel literature)*

103. Based on Mahaffey Associates' endorsement and my own visual inspection of the Dincel test panels, I have formed the opinion that honeycombing is preventable if the Dincel recommendations related to SCC mix design and placement instructions are followed.

D.3.2 Shrinkage and Thermal Cracking

104. Let us now focus on how the DCS addresses the risk of water entry via cracks.

105. We can eliminate thermal cracking in hardened concrete as being a risk in basements. This is because the temperature remains effectively constant in sub-terranean structures.

106. Shrinkage cracks (including creep) increase the risk of water entry in concrete basement walls. The wider, deeper and more interconnected cracks are to each other or to other features (such as joints), the higher the risk that they will contribute to water entry.

107. Problematic shrinkage cracks typically, but not solely, run vertically up and down the height of slender structural elements, such as walls.

108. One can reduce the likelihood of developing wide cracks by slowing down the rate at which curing takes place after a concrete pour. If shrinkage cracks are fine enough, then they can often autogenously heal.

109. Autogenous healing has practical applications for closing dormant cracks in a moist environment, such as may be found in mass structures and in water retaining or water resisting structures. Autogenous healing of concrete occurs in the presence of moisture and the absence of tensile stress when the continuity between two sides of a crack is restored without repair work. The formation of calcium carbonate crystals (CaCO3) is the primary cause for the self-healing of cracks.

110. To my knowledge, there is no unified view about what the maximum width of shrinkage cracks can be for it to self-heal. However, the most popular current opinion seems to suggest that cracks in the range of 100 to 150 microns will often self-heal in the presence of moisture and in the absence of variable tensile stress.

111. Dincel profiles include impervious webs, spaced at no more than 125mm apart. These webs act as crack initiators during the initial hardening and curing process of concrete. The crack initiators standardise the spacing and width of shrinkage cracks. That is, the DCS webbing forces the concrete to crack at specific locations and at specific distances apart so that the total dimensional change of a wall segment caused by shrinkage is more evenly distributed along the length of the structural element. The maximum theoretical shrinkage-crack width on either side of a web element is expected to be less than 0.1mm if the wall has been designed to AS3600 (where maximum drying shrinkage strain must be limited to less than 810 micro-strain).

112. In a DCS, the concrete mix is placed into the impervious and permanent polymer formwork, which retains moisture during curing far more readily than concrete placed in more traditional pervious or semi-pervious formwork. This results in reducing the overall shrinkage even further in the hardened element compared to similar elements formed with conventional formwork.

113. Fine cracks are harder for water to traverse and easier to partially or fully self-heal compared to a series of less regulated cracks which may preferentially concentrate the shrinkage at a few random and significantly wider cracks.

114. Typically, complete sealing through autogenous healing relies on the CaCO3 crystals growing towards each other from both open surfaces of a crack. As the crystals grow inwards toward each other the crack becomes finer until it is completely sealed. Complete sealing is unlikely to occur in a DCS since one side of the crack is formed by the polymer wall and it is only the concrete surface which will generate the self-healing CaCO3 crystals.

115. Even though shrinkage crack widths are expected to be reduced there is still a possibility that water may enter via such cracks, given that complete autogenous healing is not expected at the composite polymer-concrete web interface. The risk of water entry, however, is

significantly addressed by the waterproof nature of the polymer skin and the snap interlock panel-to-panel joints. This is further discussed in Section D.4.

D.4 Flexural Cracking

116. If the wall has a moment-connection to the slab-on-ground, which is most likely to be the case for basement retaining walls, a moment point of inflection will develop a small distance above the slab to wall joint. Flexural cracks will likely form at such locations and are expected to be roughly horizontal in direction (that is, the cracks will run along the length of the wall). They will be initiated on the wet side of the wall (that is, on the retaining side of the wall).

117. Other flexural cracking may also develop higher above the base of the wall, but these are expected to form on the dry side of the wall and may not continue through the full thickness of the wall section.

118. As such, the flexural cracking developed at the point of moment inflection is the critical case to consider.

119. Unlike shrinkage cracks, flexural cracks rarely autogenously heal since these types of cracks are dynamic, opening and closing depending on transitory loading. Flexural cracking can therefore be problematic in context of basement waterproofing if not properly considered.

120. Dincel mitigate the risk of water ingress at flexural cracks by:

- Placing limits on the maximum unsupported vertical span of the DCS (refer to Fig 9)
- Placing limits on the maximum surcharge from hydrostatic pressure exposed to the DCS (refer to Fig 9)
- Placing limits on the maximum unsupported horizontal span in a 2-way DCS (refer to Fig 9)
- Limiting the traffic/backfilling compaction and/or other surcharge loading to 10kPa

121. These restrictions limit the maximum out-of-plane theoretical deflection in the walls to somewhere close to 1mm.

122. It is difficult to determine with absolute certainty what maximum flexural crack width this deflection may cause in practise. Based on experience however, it would be reasonable to say that the maximum flexural crack width is likely to be between 0.15mm and 0.3mm.

D.5 Impervious Polymer Formwork and Snap Interlock Joint

123. Dincel have had their permanent formwork panels tested by CSIRO to:

- Determine the water vapour transmission rate (WVTR) through the polymer formwork
- Compare the water penetration and leakage performance of a DCS cored filled wall to that of a masonry wall

124. The WVTR test was conducted to the requirements of ASTM E96/M, which is a test used in Australia to determine if a material is suitable for use as a flashing material. Interestingly but not surprisingly, the CSIRO testing concluded that the WVTR was manifold lower than even that of seamless (liquid) membranes used to waterproof internal wet areas in habitable zones. Put in lay terms, the results indicate that the polymer is more watertight than purpose-built liquid waterproofing membranes.

125. I understand that Dincel have web links available to the public to access the full CSIRO report.

126. It is true to say that one cannot conclude from the WVTR test alone that the DCS outer skin (that is, the retaining side of the formwork) is better at waterproofing an element than a

seamless membrane. This is so because the DCS contains vertical panel-to-panel joints which could leak, whereas a functioning seamless membrane system is free of this risk.

127. The CSIRO water penetration and leakage performance test, which was tested to ASTM E514-05c, evaluated whether the composite DCS (polymer outer skin + fully compacted concrete + polymer inner skin) can prevent water entry through the depth of the wall. CSIRO concluded that the DCS successfully passed the test, resulting in a dry inner wall surface.

128. In fact, when the outer polymer skin was removed after the test had concluded, it showed that there was no evidence of water penetration even on the outer, now exposed concrete surface.

129. It is believed that a positive result is facilitated by three mechanisms:

- A higher density of concrete which decreases the concrete permeance (because of the use of SCC rather than conventional concrete. Note: in the case of the CSIRO testing SCC was not used, but rather fully compacted concrete to achieve a similar effect as if using SCC)
- Improved curing process provided by the enclosed and permanent polymer formwork, which decreases the concrete permeability
- A patented water-tight snap interlock panel-to-panel joint

130. The patented snap interlock joints are particularly effective and allows the DCS to act like a seamless waterproof membrane (refer to Fig 13). The snap interlock joint consists of barbs coupled with slurry infill from the SCC. The barbs engage with each other, like the clutches of sheet piling. A 6mm gap between panels allows only slurry to enter and fill voids/gaps.

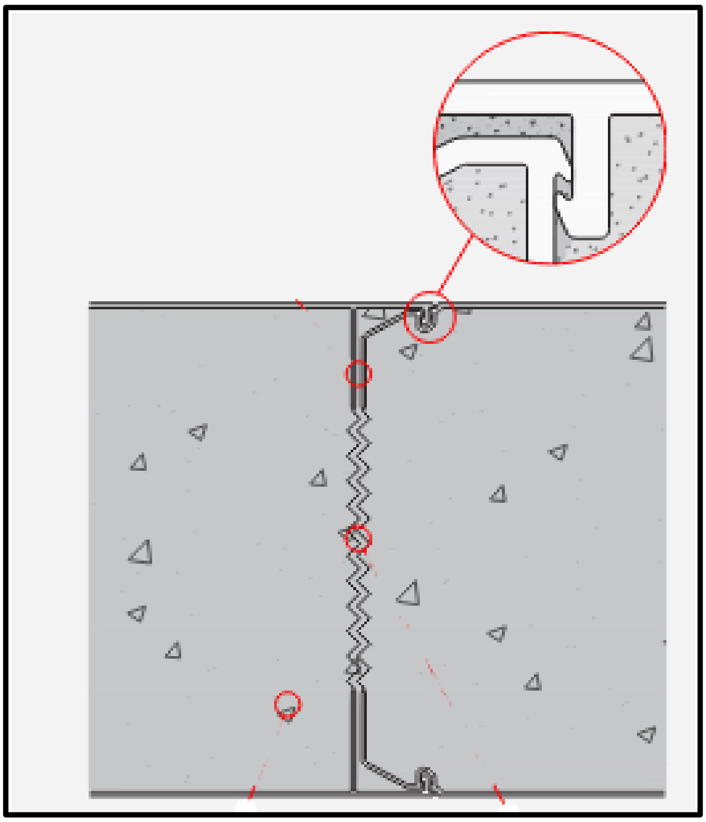

***Fig 13**.* Patented snap interlock panel-to-panel joint *(image extracted from Dincel literature)*

131. The CSIRO ASTM E514-05c testing was conducted on an unloaded segment of DCS. Under surcharge loading, it may be argued that the snap interlock joints could open to create water ingress pathways.

132. To address this argument Dincel have undertaken water-tightness testing to 3.3m (H) x 2.3m (W) x 2.3m (L) test tanks constructed with the DCS. The most severe test case was filled to a height of 3m head of water and tested under supervision from NATA accredited inspectors (Mahaffey Associates) in early 2022.

133. Mahaffey Associates concluded that the tank (constructed using the 275mm wide profile) remained water-tight for seven days and that the tank met the requirements of AS3735:2001 – Concrete Structures for Retaining Liquids.

134. I understand that Dincel have web links available to the public to access the full Mahaffey report.

135. During my visit of the Dincel test area, I inspected the test tanks. I was able to observe that the walls were dry, the wall to slab joint was dry and that the water level in the enclosed tank was still at its original level when tested by Mahaffey Associates, even though the tank had been filled for over 12 months at the time of my inspection.

136. The result of the testing provides a high degree of confidence that basement walls constructed under the conditions stipulated in this report, and more broadly by Dincel in their DCMWA, can produce a result similar to conventionally waterproofed basement walls.

E. Remediation and/or Warranty Period Extension

137. I have previously mentioned that poor supervision is usually the catalyst which creates conditions that are conducive to leaky basements. Furthermore, I have also previously mentioned that Dincel have strict quality assurance processes in place to mitigate the risk of installation errors. These mitigation processes include, but are not limited to, having fully trained installation staff, using only specified materials and having tightly governed ITP sign-off protocols.

138. Despite best efforts, it is my experience that things do go wrong on site from time-to-time. I expect that this phenomenon may extend to basements constructed with the DCS also, albeit perhaps to a lesser extent.

139. Accordingly, a good basement waterproofing strategy should always incorporate contingency measures which will allow remediation if something were unexpectedly to go wrong. Dincel incorporates a re-injectable hose in the most critical joint in the wall (that is, wall to slab and/or footing joint). This means that the joint can be repeatedly injected until accidental water entry is stopped at that joint.

140. A functional perimeter dish drain also prevents accidental water from manifesting on the top of slab-on-ground inside the basement.

141. If water manifests on the wall surface above the slab/wall joint, it can be treated with localised and focussed packer/nipple injection techniques, if access to the wall is available.

142. The optional staged 10-year warranty extensions provided by Dincel is made possible by the contingency measures inherent in the warranted DCS. That is, confidence in the waterproofing efficacy of the DCS is possible due to the ability to renew the resin at the wall-slab joint and due to the benign/stable state of the PVC polymer skin of the DCS permanent formwork.

F. Endorsement

143. It is my opinion that:

- The warranted Dincel Construction System basement wall can prevent water from the ground, which would otherwise penetrate through a below-ground wall, from causing undue dampness or deterioration of building elements and/or unhealthy or dangerous conditions, or loss of amenity for building occupants
- The warranted Dincel Construction System can produce a basement wall which performs to Grade 2, in accordance with BS 8102. *[Grade 2 performance does not permit any seepage. Furthermore, it does not permit damp areas on the inside of the structure caused by external water entry but does permit dampness/condensation on the inside wall surface caused if the dew point is reached]*
- The warranted Dincel Construction System can produce a basement wall which performs to Grade 3, in accordance with BS 8102, if a suitable inner-skin dry-wall is constructed beyond the Dincel Construction System wall and perimeter dish drain, and if appropriate dehumidification and/or air conditioning is put in place by others. *[Grade 3 performance does not permit any seepage. Furthermore, it does not permit damp areas on the inside of the structure caused by external water entry or dampness/condensation on the exposed inner dry wall surface caused by internal moisture sources]*
- In context of below-ground walls, the warranted Dincel Construction System wall is capable of satisfying clause F1P1 in NCC 2025, Volume 1

144. This endorsement is valid under proviso that the basement is constructed within the limitations described in Section C.5 of this report and the DCMWA.

145. The endorsement does not extend to the performance of the slab-on-ground or the roof structure of the basement.

G. Bibliography

146. Whether expressly referenced or not, I have relied on the following documents to formulate the opinions and endorsements expressed in this report.

- CSIRO-Test Report No. 5091 [Rev B] – Assessment of DCS Walling System
- Dincel-Waterproof Walls Conditions and Qualifications [Version 2023002(2)]
- Dincel-Construction Manual & Addendum [Version 15.2026]
- Dincel-Waterproof Warranty - Builders ITP [Rev 01d]
- Dincel- Waterproofing Warranty Terms & Conditions [Version 10.2026]
- Mahaffey Associates- Assessment of Self-Compacting Concrete in Dincel Walls [dated 13/05/2021]
- Mahaffey Associates- Testing of a Water Tank Constructed Using 275 Dincel Wall, Incorporating Dincel Water Stop, Injection Material at the Wall to Footing Slab Cold Joint for Compliance with the Liquid Tightness Requirements of Australian Standard 3735:2001 [dated 17/11/2022]
- Mahaffey Associates- Testing of a Water Tank Constructed Using 200 Dincel Wall, Incorporating Dincel Water Stop, No Injection Material at the Wall to Footing Slab Cold

Joint for Compliance with the Liquid Tightness Requirements of Australian Standard 3735:2001 [dated 21/11/2022]

- Unisearch Expert Opinion Services-Certification of Structural System [dated 23/07/2014]

Yours faithfully,

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