DINCEL
STRUCTURAL WALLING

Key Issues And Attributes To Consider When Selecting Dincel.

Permanent Polymer Formwork (PPF), such as Dincel, consists of a PVC shell which is filled with conventional or Self Compacting Concrete (SCC). PPF walls are different to conventional concrete walls such as precast or walls cast in-situ with removable formwork or masonry walls and have significant advantages over these conventional walling types, which will be discussed later in this paper. However, whilst the Australian Concrete Standard, AS3600, has been written around conventional walling types, it can be applied in full to PPF walls as verified by University of New South Wales and the University of Technology Sydney.

This document is prepared for the designer, specifier, and certifier for use as a ready reckoner addressing the key issues to consider when designing and using Dincel or any other permanent polymer formwork.

Fire

Any structure must comply with the requirements of the National Construction Code (NCC). Compliance can be met by taking one of two equivalent pathways, either Deemed To Satisfy (DTS) or Performance Solution (PS) – both are equivalent. In many instances, the DTS path is geared toward conventional construction techniques. PPF is a composite building solution so it must take the PS path to prove compliance for applications where the DTS path is not applicable or appropriate.

The most contentious area of NCC compliance for PPF is that of fire. Critically, there are two areas of performance requirements for fire – internal and external.

Internal: There is a suitable test method that manufacturers of PPF can undertake to prove compliance. Dincel, along with other PPF manufacturers in Australia, have had their products extensively tested by organisations such as CSIRO and Warringtonfire and have been found to meet the DTS requirements for use as internal loadbearing walls.

External: The NCC does not mandate that external walls must be non-combustible, rather it is concerned with the spread of fire. PPF cannot offer DTS (non-combustible) for external walls in class 2 to 9 buildings because there is no suitable testing method for composite products in the NCC. As such the PS path must be followed. It is precisely for these types of situations that the PS pathway is included in the NCC. The key concern of this Performance Requirement is the spread of fire. Through large-scale tests, and comparative testing against DTS materials, Dincel has proven compliance with the spread of fire requirements of the NCC (C1P2). Because Dincel has proven direct compliance with the relevant Performance Requirement of the NCC, there is no need to certify against the corresponding DTS provision (C2D10(1)(a)).

Confirmation of Compliance: Dincel provided all appropriate documentation to an expert third party fire engineer (Omnii). Omnii have subsequently published an Evidence of Suitability Report confirming Dincel's claims. In addition to this, Dincel has sought third party assessment of conformity and received CodeMark Certification for the above-mentioned fire performance requirements of the NCC.

Further, Dincel has received a BRAC Certificate of Accreditation in Victoria for use in façade/external applications. With Dincel Walls meeting the DTS requirements for use as internal loadbearing walls, this means that Dincel has multiple certifications (CodeMark and BRAC) clearly confirming that it can be used for both internal and external applications in Victoria.

Dincel has also received unrestricted acceptance in New Zealand for both internal and external use.

Certification

A Certifier no longer needs to review in detail the test results achieved by Dincel, rather they can rely on Dincel's CodeMark Certificate of Conformity. In NSW, a Certifier relying on a valid CodeMark Certificate when issuing a Construction Certificate will incur no professional or personal liability (Environmental Planning and Assessment Act 1979 (NSW) Section 4.15 (4) and (5)).

Insurance

In the recent past, following fires in Melbourne and London, the NCC has singled out aluminium cladding with foam core to be non-compliant. At the same time, some insurance companies have taken it on themselves to expand the definition of non-compliant claddings to also include a fire behaviour which is also applicable to PPF, and hence refuse to provide PI Insurance to Certifiers who certify PPF, despite PPF complying with the requirements of the NCC. This has led to Certifiers refusing to certify complying PPF due to the lack of PI insurance coverage. Investigations by Dincel have revealed that there are at least three insurance companies in Australia who provide policies that match the requirements of the NCC – i.e. they will provide PI insurance for Certifiers who certify PPF. Dincel can provide details of insurance companies offering such PI insurance.

Voids

Air voids, honeycombing, and segregation can lead to many structural defects such as water ingress, steel reinforcement degradation, structural inadequacy and fire and acoustic non-compliance. As such they must be eliminated. There are two ways to eliminate voids in concrete walls -

1. Use high slump concrete provided the concrete is a minimum 180mm slump at truck discharge and the concrete is vibrated adequately for the full height of the wall, this is an adequate methodology for PPF and removable formwork but is reliant on

   a. correct slump concrete being used and not cheaper low slump concrete or concrete with large aggregate – like slab mix, and

   b. on the skills and capability of the vibrator operator. Unfortunately, the role of the vibrator operator is not seen on site as critical and is often left to the least skilled operator leading to under vibration (voids) or over vibration (segregation). This process, is quite problematic with Besser blocks since it is not possible to vibrate a 140mm or 190mm thick Besser block wall due to the mandatory horizontal bar requirements.

   It is also an issue with permanent formwork where the faces are not mechanically fixed, but rather glued – the pressure of the concrete coupled with the mechanical action of the vibrator could result in bulges or formwork failure where the face is stripped off the formwork.

2. Use Self-Compacting Concrete. This mix eliminates the need for vibration and ensures that concrete and/or concrete slurry travels into every crevice. The critical issue is the ability of the formwork to accept the very high pressures exerted by the SCC. In most instances this is not the case. Dincel however, is ideally suited to the use of SCC due to the geometry of the clip design.

Particularly important to note in the case of any type of permanent formwork, is that voids are more prone to form if the space between webs of the formwork are less than 100mm. This relatively narrow spacing for double faced horizontal and vertical reo-bars can cause congestion of reo bars particularly at top and bottom of the walls where lapping between vertical bars is required.

Further, it should be noted that the porous formwork surfaces of Besser block, fibre cement and poorly oiled plywood surfaces can lead to voids if not appropriately vibrated. Further, walls with extensive horizontal reinforcement or heavily congested areas are prone to voids under & around the bars (see also section below "Composite Action").

Detection of voids:
Dincel is of the view that voids should be eliminated, not detected and rectified. Rectification is costly and the integrity of the wall (structural, fire, acoustic etc.) could still be compromised. The best way to avoid voids is to use an appropriate specification SCC. This eliminates the reliance on vibration (none is needed) and the SCC invades every part of the formwork. Dincel is so confident of this that they will offer a void free warranty if SCC is used (See Dincel Website for details of Void Free Warranty).

Some suppliers of formwork offer scanning services to detect voids. As noted above it would be better to eliminate voids as rectification is problematic. In addition, detection methodologies have significant shortcomings.

Thermal Imaging (TI) Cameras: TI cameras detect temperature differentials. Given the concrete curing process is exothermic, a TI camera is perfect for following the flow of concrete in a wall being filled against the relatively cooler environment. Whilst a TI scan of a wall at the time of pour can assist in ensuring consistent flow and aid in the process of filling a wall, it will not provide pertinent information about voids once the concrete is cured.

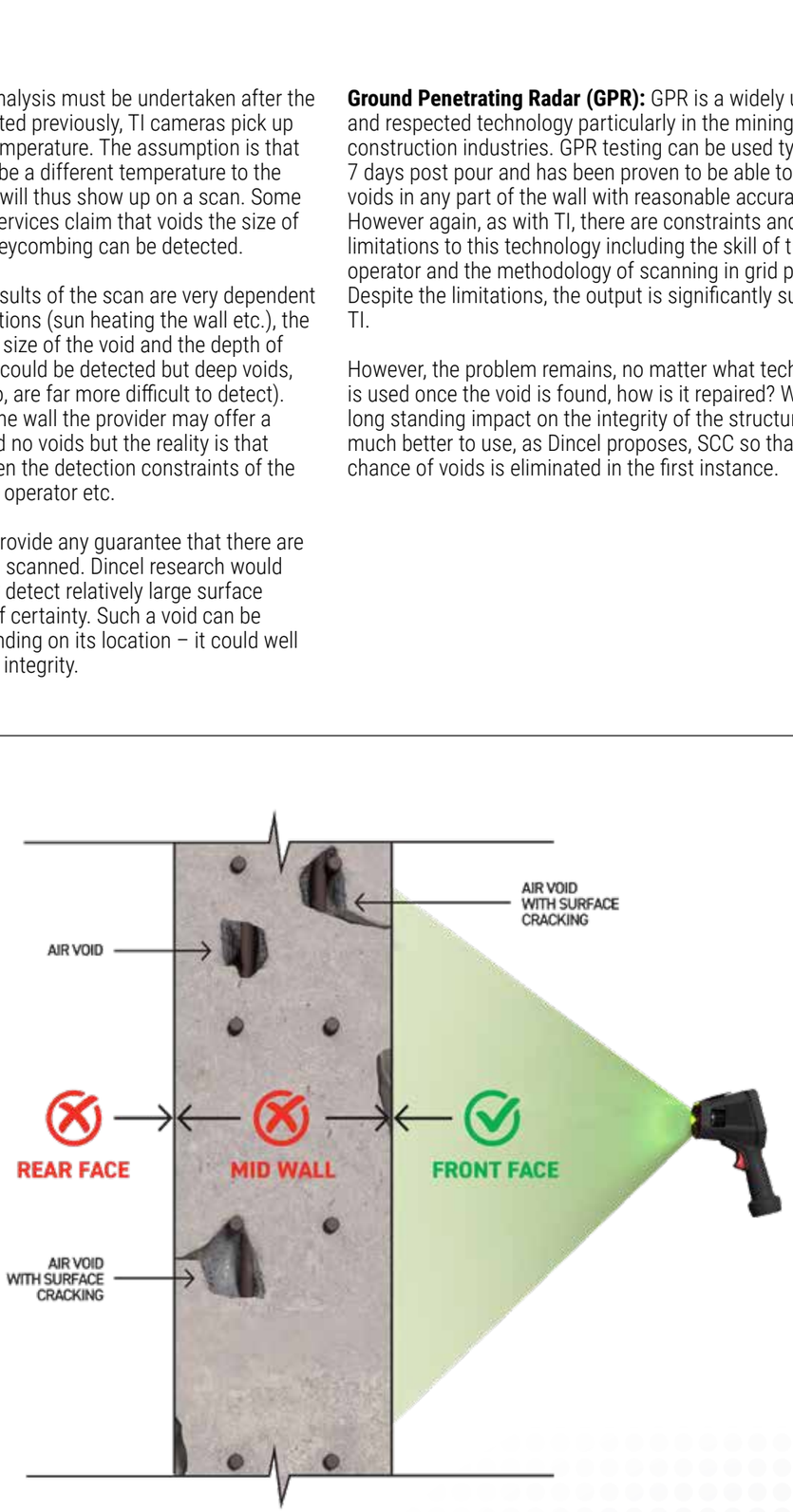
Proper void detection analysis must be undertaken after the concrete has set. As noted previously, TI cameras pick up differentials between temperature. The assumption is that a void within a wall will be a different temperature to the solid concrete wall and will thus show up on a scan. Some providers of scanning services claim that voids the size of golf balls or indeed honeycombing can be detected.

The reality is that the results of the scan are very dependent on environmental conditions (sun heating the wall etc.), the skill of the operator, the size of the void and the depth of any void (surface voids could be detected but deep voids, say under horizontal reo, are far more difficult to detect). Following scanning of the wall the provider may offer a report saying they found no voids but the reality is that they found no voids given the detection constraints of the imaging equipment, the operator etc.

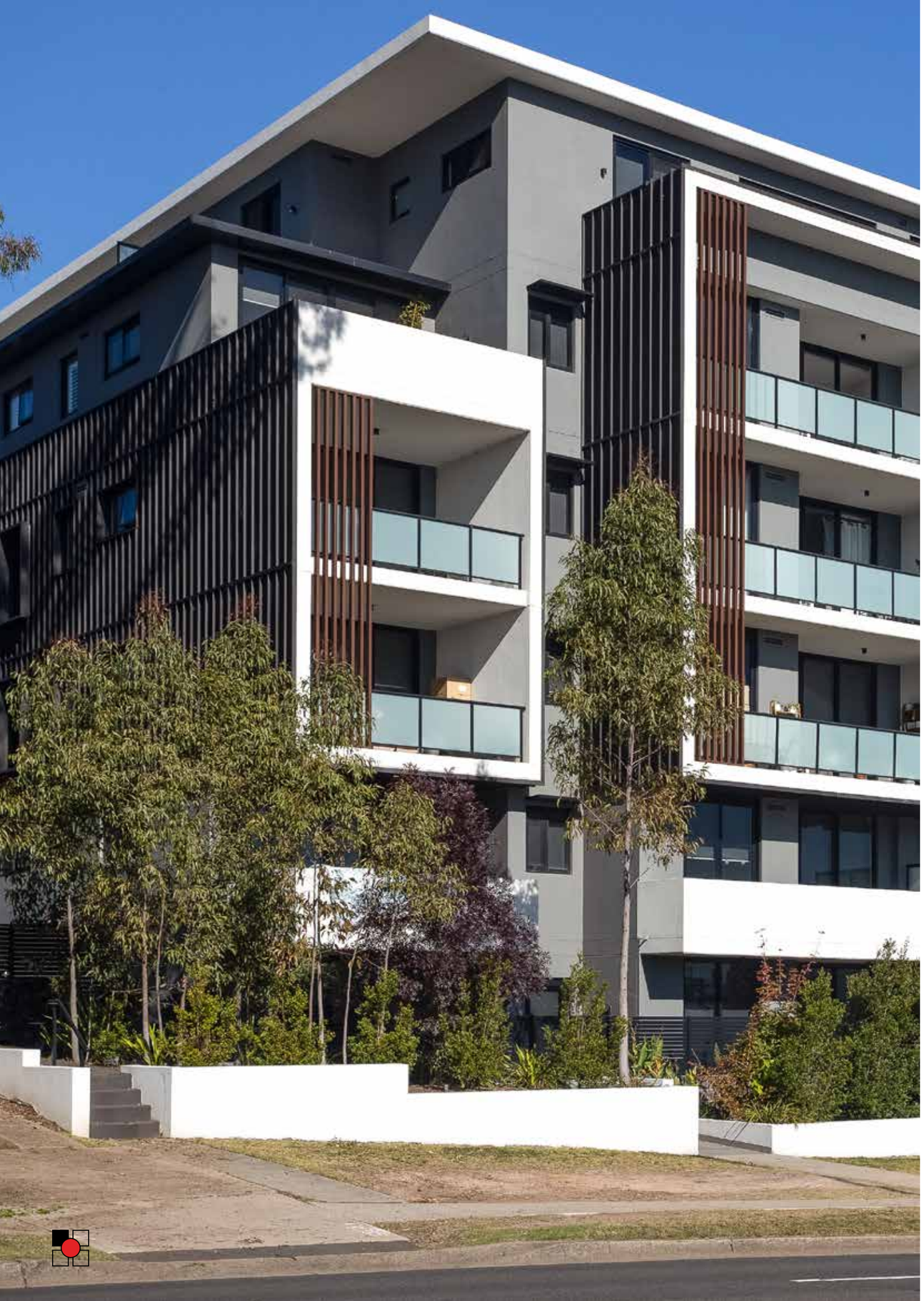
They will certainly not provide any guarantee that there are no voids within the area scanned. Dincel research would suggest that TI will only detect relatively large surface voids with any degree of certainty. Such a void can be quite problematic depending on its location – it could well severely impact a wall's integrity.

Ground Penetrating Radar (GPR): GPR is a widely used and respected technology particularly in the mining and construction industries. GPR testing can be used typically 7 days post pour and has been proven to be able to detect voids in any part of the wall with reasonable accuracy. However again, as with TI, there are constraints and limitations to this technology including the skill of the operator and the methodology of scanning in grid patterns. Despite the limitations, the output is significantly superior to TI.

However, the problem remains, no matter what technology is used once the void is found, how is it repaired? Will it have long standing impact on the integrity of the structure? It is much better to use, as Dincel proposes, SCC so that any chance of voids is eliminated in the first instance.



Thermal Imaging Limitations



Water Ingress

Water ingress into a structure that has not been specifically designed into that structure (such as in the case of a purposely designed drained basement) will create both structural integrity issues as well as amenity issues for occupants of the building. Uncontrolled water ingress must be eliminated. Further, the impact on the environment being caused by removing water from the water table is of considerable concern to State Government authorities and Local Councils. The methodology of the application of The NSW Water Management Act 2000 in respect to basements has recently been updated, with fully tanked basements being the preferred design methodology.

At least six Councils in the Greater Sydney region mandate tanked basements where the water table is impacted. (For further information on which Councils require tanked basements or indeed how any Council in Greater Sydney address basements impacting the water table, please contact Dincel). In situations where the water table is likely to be impacted, developments must be referred to WaterNSW. If a tanked basement is not specified, significant hydrological data needs to be collated and provided with the DA for review. This review process is quite lengthy and onerous conditions may be applied. The length of time for any consent and the extent of any conditions would be significantly less for a tanked basement.

Dincel has had the joints of the panel extensively tested and thus can rightly claim that the Dincel Wall is waterproof (please see Appendix 1 for details of this claim). No other provider of PPF has made this claim, the closest being a claim of “water resistant” joints.

The weak point of the system is the cold joint i.e. the base of wall & slab/footing junction. Unless the cold joint is sealed at the water/ground pressure face, water will invade the wall. Concrete additives will not seal this joint and a water stop strip, if effective, will only stop water at the point of installation. If there are any other routes of passage for the water, say at the interface between concrete and PPF web, the water will continue to travel through the wall. So, the only real solution to date has been to over-excavate and bandage the cold joint or to have a fully tanked membrane. Dincel has now overcome this issue with the development of the Dincel Water Stop. This extrusion is cast into the base slab on the pressure face. An injection hose is then inserted and the Dincel wall built above. Following structural completion, polyurethane resin is injected, sealing off the cold joint at the pressure face. Dincel offers a zero-leak waterproof warranty for up to 50 years for this system (conditions apply).

Some of the consequences of not specifying a fully tanked basement include:

- a rejection of DA from local councils requiring a fully tanked system or requiring zero discharge into the public stormwater collection system
- a very detailed hydrological study and analysis at significant additional time & cost
- a water authority assessment which will take significant additional time and will come with potentially onerous conditions and reporting requirements for both the construction period and the life of the project
- a significantly more energy intensive building coupled with ongoing maintenance costs to building owners
- an untanked, leaking basement that will potentially set up an environment conducive to mould/mildew growth and could be contrary to the requirements of the NCC

Mould & Mildew

The NCC has always focused on water penetration and its effects on the amenity of a structure – mould and mildew development. Going forward, it is absolutely apparent that the NCC will take an even more rigorous approach.

a. NCC 2022 - F8P1 and H4P7 for class 1 and 2 buildings require the protection of occupants which requires the prevention of mould/mildew development because of condensation and/or water/water vapour ingress.

b. The draft of NCC 2025 indicates that from its release in May 2025, the NCC will require waterproofing for class 7 and 8 buildings. The draft, as it stands, shows some inconsistencies. It is possible, that once the inconsistencies are addressed, NCC 2025 will most likely require waterproofing in all basements of Class 2 to 9 buildings. It should also be noted that storage spaces are regularly designed within the basements of Class 2 buildings. Such storage spaces frequently contain materials which can feed or promote the growth of mould/mildew in moist areas. The occurrence of mould/mildew within storage areas are a direct impact to the amenity of the structure.

Research by Dincel suggests that in many instances, insurance companies do not cover water leaks at external walls both above and below ground.

Aside from façade walls and balcony issues the most probable area of water entry into a building, and hence development of mould and mildew, is the basement. The best way to eliminate mould/mildew is to eliminate water ingress – see section above.

Composite Action

PPF does more than just encapsulate concrete, it also acts as the mould for the concrete to form a wall. Through composite action, it enhances the properties of the wall.

Horizontal reinforcement elimination/reduction: The permanent Dincel polymer webs work as crack inducers/controllers. This way, concrete is articulated at a maximum 127 mm centers. This eliminates the need for wall joints, irrespective of the height and length of the wall, and crack control bars (i.e. horizontal bars) can be eliminated for non-shear walls. This proposition has been certified by the University of New South Wales (for details please visit the Dincel website at www.dincel.com.au). Elimination of horizontal steel is a major advantage as it provides unimpeded concrete flow leading to a significantly reduced chance of voids. In addition, elimination of steel reduces installation time and improves safety and recyclability.

Concrete hydration: The greater the hydration of the cement, the higher the strength of the concrete. Conventional formwork is stripped after a few days allowing moisture to escape and the hydration process to end. Besser blocks are porous and so the water escapes/evaporates quickly ending the hydration period. With PPF, the concrete remains encapsulated forever and as such hydration will continue until all the cement is hydrated. Testing by Holcim Concrete has showed a 60% increase in strength within 90 days for a concrete mix containing 50% less cement than for a conventional mix. Extrapolating, with 100% cement use the increase in both compression and tension would be at least 2 times greater than the specified strength within 90 days. From an environmental point of view this is excellent news as usage of cement (a huge CO2 gas generator) could be halved for constructions using Dincel walls.

Composite action: Dincel Wall is a composite structural element and not just permanent formwork. Extensive tests have been conducted at UTS that have shown the superiority of wall performance in terms of resilience, ductility, flexural and shear strengths. These tests were conducted in accordance with AS3600-Appendix B and code compliance has been certified by UTS proving that it is possible (subject to bracing design) to backfill a 275 Dincel basement wall, up to 3 m high, 24 hours after concrete filling. This has been corroborated by both UTS lab tests and actual field use.

Impervious skin: The PVC skin of Dincel forms extends the life to any structure by preventing external contaminants entering the concrete matrix and compromising the steel reinforcement. There is potential for steel placement to be compromised at various points in the construction process. If this were to occur and concrete cover requirements not met, durability of the Dincel wall would be maintained due to the impervious skin and waterproof joints. Because of the impervious skin, there is no need to treat the external face for water protection and thus over excavation is not required for post pour access. It should also be noted that Dincel Wall has the potential to be designed as a thinner wall in comparison to conventional or non-waterproof PPF Walls due to the reduced concrete cover requirements resulting from the provision of the protective impervious skin. This could easily result in 50mm less concrete thickness being required.

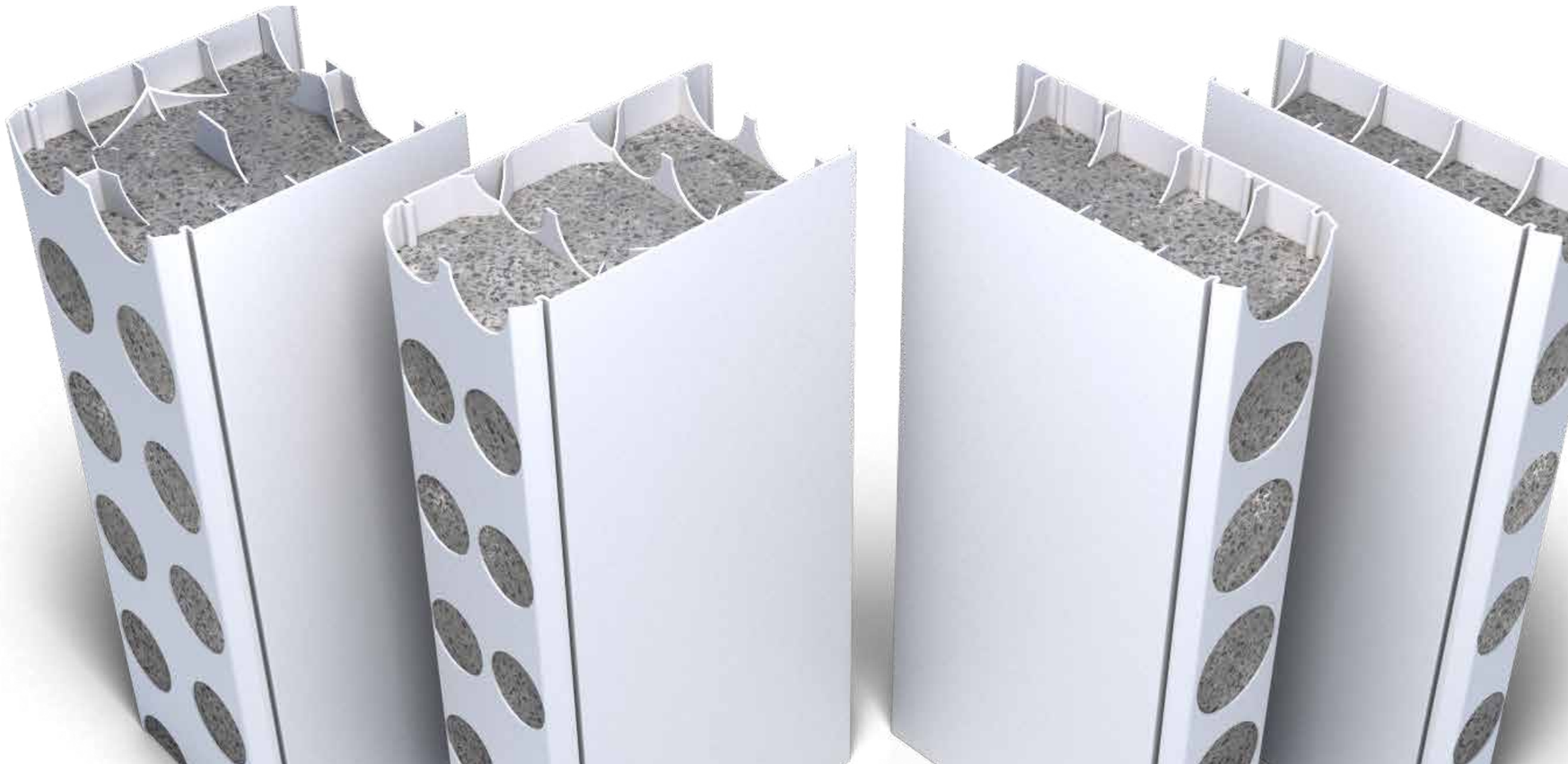
Dincel Panel Design

The Dincel panel itself has a number of particular design advantages over alternative PPF systems in the market.

Panel Size: The Dincel panels are typically 333mm wide (i.e. for 110, 155, and 200 Dincel), that is, three panels per metre. The most popular competitor to Dincel is 250mm wide or four panels to the metre. This means Dincel is 25% faster to install than the competitor product.

The Dincel Clip: The geometry of the Dincel clip makes it fundamentally stronger than alternatives in the market place. This means that it can withstand the extreme pressures of SCC and can also be poured in higher lifts meaning that again, Dincel is quicker to install. The clip also includes a patented barb that ensures the waterproof characteristics of the clip joint. No other PPF has this feature or claims to have a waterproof joint.

275 Dincel: The 275 Dincel panel has been specifically designed to enhance the composite action of the panel and concrete. Designed with the concept of a hooped wine barrel in mind, the 275 Dincel panel is the strongest in the market. It can be filled to over 5 metres in height in one concrete pour. It also has the ability to be backfilled to a 3 metre height in just 24 hours after concrete pour. This provides significant advantages in terms of construction speed.



Dincel is the world's leading manufacturer and supplier of permanent PVC formwork for waterproof structural walls. Our purpose is to improve construction methodologies and outcomes, making buildings safer, faster and more economical to build. We commit to delivery of a fully compliant, warranted, cost effective and customised permanent PVC formwork system for structural walls.

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