DINCEL
STRUCTURAL WALLING

DINCEL STRUCTURAL WALLING

RENDER CRACKING

(A) INTRODUCTION

The following is information explaining how to avoid or minimise render cracking in any concrete wall, including Dincel-Wall.

Can Dincel-Wall have render application? The answer is YES as there are many successful render applications on Dincel-Walls. There are a significant number of variables other than the base wall (i.e. conventional concrete walls or Dincel-Walls) which will have an effect on the potential for cracking of the render finishes.

These variables are mainly the type and thickness of render selection, moisture level of render and how it is applied.

THE FOLLOWING CHECK LIST WILL ASSIST YOU IN ACHIEVING A SATISFYING END RESULT.

DINCEL-WALL – RENDER APPLICATION CHECK LIST	
1. Dincel-Wall Installation	• Ask the Dincel-Wall installer/builder to sign the Dincel Installation Acceptance Form located in the Dincel Construction Manual, Section I to achieve good workmanship.
2. Concrete Mix Use	• Minimum 180mm slump. • 25Ø pocket vibrators to be used.
3. Surface Preparation	Dincel's face must be clean from any dust and grit. Refer to render manufacturer's specification.
4. Render Type Selection	**100% Acrylic Render with polystyrene balls as filler.**
5. Render Thickness	Recommended by Dincel to be no less than 10mm for multiple reasons. Walls that are not square and/or out of plumb may require additional render thicknesses to correct the misalignments. As a result, the builder/developer is highly recommended to implement Item No: 1 above.
6. Paint	Refer paint manufacturers.
7. Dark Colours	Using dark colours on any surface will represent problems, the thickness of the render is of prime importance for heat insulation purposes. Use only after consultation with your render material supplier. Finishing top-coats should incorporate sun-ray reflectors and render joints must be provided when dark colours are used.
8. Render Applicator	**Use only applicators accredited by your render manufacturer.**

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Dincel is not a render material supplier or applicator. Therefore, Dincel does not assume any responsibility for render applications because of many factors outlined in this document that are beyond Dincel's control.

Delamination of applied render on any surface, including Dincel, can happen unless the render manufacturer's specifications are strictly adhered to. **All render types, thicknesses, colours and applications must be discussed and agreed with the paint/render supplier and the selected applicator.**

Refer Frequently Asked Questions

Dincel website for Finishes – **(Download FAQ/Finishes, Questions 11 and 12)**.

(B) WHY RENDER CRACKING OCCURS

There are many reasons for render cracking:

1. The **base wall cracks hence render cracks as well**. The reasons are:
   - **Building foundation settlement** due to inappropriate design, nearby trees, leaking sewer/stormwater pipes, etc.
   - **Building materials** of a porous and brittle nature (e.g. fibre-cement, brick, block, concrete) **shrinks and expands**, hence results in the wall and render cracking. The only way to avoid this is to provide joints in the conventional materials and carry these joints through the render.
   - **Settlement of floor slabs** carrying the walls above the floor slabs causing cracking in the walls.
2. **Cracking in applied render**. Types of renders include:
   - **Conventional sand and cement**.
   - **Modified acrylic render** which is achieved by adding sand and cement into the polymer render.

   Both of the above renders can be applied in reasonable thickness to hide the workmanship defects of the base wall. The thicker these types of renders are the more susceptible to shrinkage and temperature related cracking which is unavoidable unless joints are used. Porous sand/cement absorbs water/moisture into the body of the render. When the external temperature is below 0ºC, water freezes and expands which result with unavoidable render cracking. The rendered joints must also be placed at the base wall joints.
   - **100% Acrylic Render**. Due to its non-brittle nature, perfect rendering material (i.e. no sand and cement) is significantly more flexible in resisting render cracking. The only disadvantage of this material is that it can only be applied in thin layers. If the base wall is not constructed properly, increasing number of rendering layers, mainly due to labour cost increases the cost of rendering.
   - **Recommended Dincel Render**. 100% Acrylic Renders are mixed by some manufacturers with small polystyrene balls to increase the applied render thickness of up to 10mm – 15mm in one application which also provides significant insulation properties. Dincel recommends this type of render solution which is currently available from many render manufacturers who operate in Australia.

(C) WHY DINCEL IS DIFFERENT

1. **Dincel-Wall consists of hydrophobic permanent polymer formwork for concrete infill.**

   The polymer surfaces of Dincel-Wall, as tested by CSIRO, are 180 times less porous than the threshold given by Australian standards for flexible membranes.
   The Dincel panel joints have been tested by CSIRO under 6m head of water pressure and confirmed as waterproof. Refer **(Download –Dincel Wall Waterproofing Warranty)**.
   Therefore, Dincel is unlike other porous (i.e. hydrophilic) natured materials, such as fibre-cement, brick, block and concrete have:

   - Impervious membrane at both surfaces.
   - Which act as vapour barriers. Other non-Dincel-walls must have vapour barriers on the warm face of the building's façade wall in accordance with the Building Code of Australia.

   These privileges offer Dincel-Wall:

   - Single skin façade wall without conventional cavity construction.
   - The render applied to the face of Dincel, unlike conventional materials, is therefore not for the protection of the base wall material which is only for aesthetic purposes. Therefore, failure of the painted render on Dincel-Wall will not cause sick building syndrome, decay, rot, mould/mildew development.

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2. Shrinkage Cracking in Concrete Infill of Dincel-Wall

This type of cracking is not externally visible on Dincel-Wall because of Dincel-Wall's polymer face. The inbuilt Dincel crack inducers cracks the concrete infill at 125mm maximum centres. This is similar to concrete footpaths having joints at 1.5m to 2m centres. The only difference is that Dincel joints are at 0.125m (125mm) centres. However, these cracks are not visible, hidden behind the waterproof Dincel polymer. For further explanation refer:

(Download – Testimonials) Refer WATPAC Testimonial

(Download – Common Engineering Questions, Item No: 1)

90% of shrinkage in concrete infill occurs within the first couple of days which is long before any render application on Dincel-Wall. Therefore, there is no remote possibility for shrinkage of the concrete infill of Dincel-Wall causing render cracking. This is quite the opposite in the case of conventional hydrophilic nature building materials. They are in constant movement due to varying relative humidity conditions, wetting/drying, freezing/thawing and contact with water.

3. Thermal Effect on Dincel-Wall

(a) No Render on Dincel-Wall

In the base Dincel Wall, prior to rendering, similar to shrinkage behaviour Dincel's crack inducers at 125mm centres accommodates the temperature movement.

The Dincel panel joints located at 333mm centres have been designed to have 1.5mm thermal movement accommodation. The Australian maximum daily temperature rarely exceeds 40ºC. At this maximum daily temperature, if the minimum daily temperature is 20ºC, then the variation in temperature is $\Delta T = 40 - 20 = 20$ºC. This will result in ΔT (20ºC) x coefficient of thermal expansion between polymer and concrete (72 – 12) x 10-6 x 333mm at each Dincel Panel Joint = 0.4mm < 1.5mm movement allowance at each Dincel panel joint. Therefore, thermal movements can be easily accommodated without any joints in the Dincel base wall.

(b) With Render on Dincel-Wall

This means that the 1.5mm joints for temperature movements are filled with render which will inhibit thermal movement at the Dincel panel joints.

(i) Light and Pastel Coloured Render

The minimum base render is 6mm thick, 100% acrylic render with polystyrene balls as aggregates provides insulation properties on Dincel-Wall. At 40ºC daily temperature with the subject type of render and thickness, the most likely $\Delta T = 20$º as before, this will require 20ºC x (72 – 12) x 10-6 x 333 = 0.4mm which require 0.4 ÷ 1.5 = 26% elasticity in the render itself without joints at conventional spacings.

100% acrylic render with polystyrene balls as aggregates provides 20% elasticity according to the manufacturer. The recommendations are subject to the approval of the render manufacturer for $\Delta T = 20$ºC (i.e. daily temperature of 40ºC). The following must be considered:

- Base render thickness of 6mm (plus 3mm + 1mm finishing render = Total render thickness of 10mm).
- Joints in the render at 6m centres.
- Using sun-ray reflectors at the West and North facing walls.

(ii) Dark Coloured Render Use

Dark colours are not preferred by the paint/render manufacturers on any surface.

The reason for this is that the surface temperature on particularly the western summer wall can reach up to 88ºC according to the paint manufacturers which provide $\Delta T = 88$ºC - 20ºC = 68ºC. This represents a condition that is very hard to control for render cracking.

When dark colours are used, Dincel recommends customers to work in close communication with the paint/render manufacturers. The following are vital to consider.

1) **Base render thickness, minimum 10mm thickness (plus 3mm + 1mm finishing render = Total render thickness of 14mm)**.
2) **Sun-ray reflectors must be adopted** to reduce the surface temperature on the wall.
3) **Must use render joints at maximum 5m centres**, particularly on the Western and North-West walls.

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Note: Paint manufacturers do not offer warranty for the use of dark colours unless manufacturer's specification is followed which consists of sun-ray reflectors and joints at their recommended centres for any type of surface, including Dincel.

Refer to the following photo and joint detail.

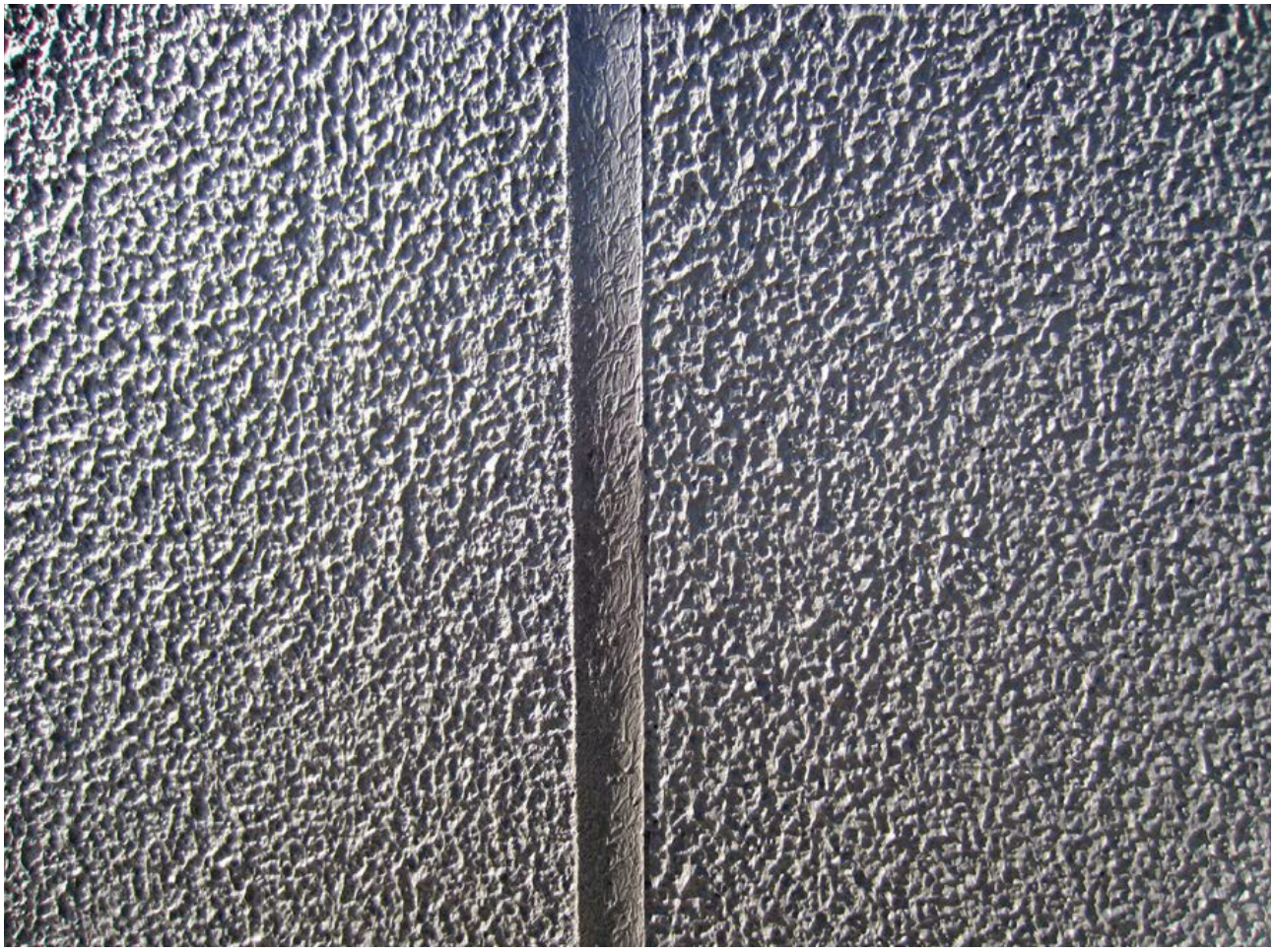

PHOTO SHOWING WESTERN WALL – DARK COLOUR 5MM THICK RENDER WITH 5MM WIDE JOINT APPLICATION ON DINCEL-WALL

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(iii) Dark Colour and High Water/Moisture

Refer **(Download – Dincel Wall Waterproofing Warranty)** and read the topic – **"Why Dincel is Waterproof"**.

The point of the above explanation is that Dincel-Wall is waterproof. Therefore, no water transmission externally or internally out of Dincel-Wall is expected to happen as per the CSIRO test for walls installed and concreted according to the Dincel Construction Manual. **The concreting for the CSIRO tests were organised and installed by CSIRO themselves, not by DCS**.

The above does not mean that the Dincel joint is airproof. The Dincel polymer itself is tested by CSIRO for vapour transmission which is 180 times better than standards of flexible membranes. However, this does not mean that the joint itself has the same vapour transmission rate of Dincel polymer. **The vapour or internally developed air, gas under pressure will tend to escape through the joints located at 333mm centres in the case of the plain Dincel-Wall without any render finish on them within a few weeks of concrete placement**.

This is most likely the reason why Dincel -Wall without an external render system does not develop additional vertical ridges after concrete pouring, even if it has significant amount of water inside of the Dincel forms. The Dincel joints allow vapour/air transmission from joints under pressure, particularly in the absence of paint/render application of Dincel-Wall.

However, on the other hand, the fact is when render is applied on Dincel, the vapour transmission at the Dincel joints is significantly reduced. Perhaps it is not fully airproof but very close to total air tightness will be assured (particularly when the render paint is applied with a top coat which is a silicone membrane to stop vapour transmission).

The presence of dark colours increases the surface temperature of the western wall up to 88ºC according to paint manufacturers. This draws the moisture of all concrete walls including Dincel towards the warmer wall surface. The excess moisture (i.e. 11% free water not used in cement hydration, W/C ≥ 0.5, leaving the top of the walls open to absorb rainwater) cannot escape due to the presence of paint/render blocking the 1.5mm gap at the Dincel panel joints, particularly incorporating top coats (i.e. silicone based vapour barrier) hence results in vertical ridges at the joints.

Let us visualise the following scenario where a concrete in-filled Dincel panel with a good surface appearance is rendered and painted with a dark colour (refer to the following photo). It has been experienced that vertical ridges at the Dincel panel joints occurred after painting the Dincel panel's surface with a dark colour. Refer following photos displaying the described phenomenon. **The answer is obvious for the subject phenomenon. The excess moisture (due to leaving the top of the walls unprotected) is trying to escape and cannot pass through the joints because of the applied paint/render on the Dincel joints.** This phenomenon with the excess moisture is further exacerbated by the presence of a dark colour. Technical literature indicates that the surface temperature can reach up to 88ºC with the application of a dark colour on any surface which is adequate to create internal vapour pressure in a closed container. **As an example, compare a half full water bottle with an open lid, a full bottle with a closed lid and a full bottle with a closed lid painted in a dark colour. Observation of the behaviour of these bottle samples will be a good example in describing the phenomenon that has occurred with Dincel-Wall with the concrete having high moisture and painted a dark colour.** Vapour is trying to escape where the container's stiffness is reduced which is the periphery of the container (i.e. Dincel joints). This way, internal pressure causes the joints to move outwards. Therefore, the culprit must be the dark colour usage together with excessive moisture presence.

The reason for the above described phenomenon occurring is because of the dark colour and the Dincel-Wall top not being protected against excessive moisture/rain conditions as it is obvious from the following photos.

The above described issue is not only relevant to Dincel-Wall. The same phenomenon occurs in conventional concrete walls resulting in paint bubbling and peeling.

The obvious solution is to use total 10mm or 14mm thick render, depending on the colour selection and, protect the top of the walls for a minimum of 4 weeks prior to the application of render and use joints in the render.

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FENCE WALL – BEFORE RENDER

NO VERTICAL RIDGES AFTER CONCRETING AND BEFORE THE RENDER APPLICATION SHOWN IN THE PHOTO BELOW.

NO PROTECTION AT THE TOP OF THE WALL

WESTERN FENCE WALL – AFTER RENDER

Vertical ridges at about 2mm at the Dincel panel joints appeared on the rendered wall for the following reasons:

- Render does not have enough thickness (only 1mm to 1.5mm).
- Dark colour use at western wall without joints.
- Top of Dincel wall is not closed as shown in the photo (i.e. no Dincel top cap profile or concrete/stone/metal cap) to avoid the water entry into Dincel wall.

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(c) With External Applied Insulation Having Render Finishes

As a requirement of the Building Code of Australia (BCA), Section J, it may be necessary to provide supplementary insulation to a façade wall of the building to satisfy regional requirements.

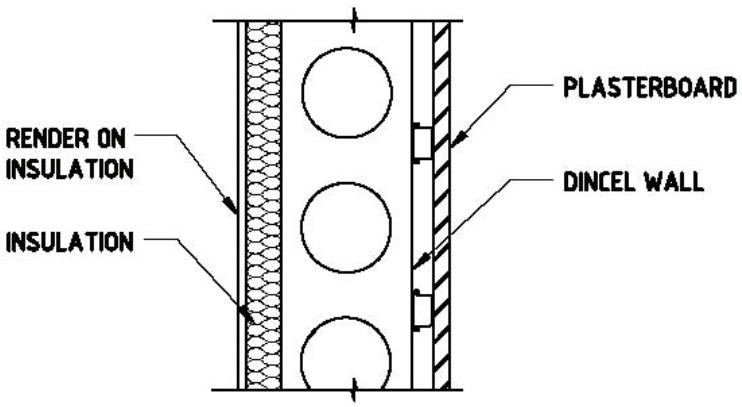
The concrete wall, irrespective of thickness, does not satisfy BCA, Section J. It is therefore necessary to insulate the façade walls internally or externally.

In the case of externally applied insulation, an insulation material of appropriate thickness to satisfy the thermal insulation "R" value is attached to the face of Dincel-Wall.

This methodology provides two advantages.

(1) Significantly reduce the "△T" at the Dincel-Wall behind the insulation as shown below; hence thermal movement is significantly reduced.

(2) In the absence of render on the Dincel face, the thermal joints are free to move hence no joint requirement in the base Dincel-Wall.



DINCEL INSULATED FACADE WALL DETAIL

4. Structural Performance of Dincel-Wall

Dincel-Wall has been tested by the University of Technology, Sydney and its suitability is certified for magnitude 9 earthquakes.

The earthquake tests demonstrated that polymer encapsulated Dincel did not display any visual cracking. Refer **(Download – Earthquake Test)**.

The above tests are testimony that the Dincel Base Wall will not display visible cracks because of structural foundation movement and suspended floor deflection which normally result in cracking in conventional walls.

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