

CMAA

CONCRETE MASONRY
ASSOCIATION OF AUSTRALIA

CM06

Concrete Masonry –
Unreinforced
Concrete Masonry
in Residential
Construction

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Introduction

Concrete masonry is a building material that offers great benefits for use in residential applications, such as sound and thermal insulation, structural integrity, fire resistance and durability. Concrete products come in a wide range of colours and finishes (and even in the form of bricks), through the most commonly used are grey blocks. Typical block construction consists of - retaining walls, load bearing walls, basements, commercial and landscaping projects. The availability of concrete bricks and the various finishes and colours available has made this a desirable product for the residential market.

Residential construction with concrete masonry units differs from building in clay bricks as both units behave differently in their service life. Clay bricks tend to expand where concrete experiences shrinkage, hence concrete masonry units (CMUs) need control joints. Concrete also has a higher absorption rate due to its physical properties, which requires a different approach during construction. CMUs can often be shaped in various forms and still retain their structural integrity.

In residential settings, most builders use basic concrete bricks and will sometimes render over the surface face for aesthetic reasons. Concrete blocks are also used in high wind or cyclonic prone regions, in which building codes specify that reinforced, core-filled blockwork must be used to counter the wind forces. This guide will give an insight into how to build using unreinforced concrete masonry in residential settings.



Section 1: Construction

Concrete Masonry is renowned for its versatility and serviceability. When used in accordance with the National Construction Code (NCC), it is suitable for residential building locations and it is available in exposure grade varieties. One of the main issues that are overlooked is the provision of control joints at required intervals. Another issue that commonly arises either as a result of poor blockwork or tradesmanship is damaged rendered finishes. Render can crack and even fall right off the surface if guidelines and proper techniques are not adhered to in the process. This section focuses on the correct procedure to address these two main problems and construction processes that will ensure the best results.

1.1 Control Joints

Control joints must be used in all masonry walls in order to prevent cracks appearing. The NCC requires all walls constructed from concrete masonry to have a control joint at regular intervals. Control joints here refer to the contraction joints introduced in AS 3700. This helps counter any problems brought by:

- Shrinkage of concrete masonry units
- Thermal movement
- Differential settlement of foundations

The maximum spacing of control joints should be calculated based on AS 3700, and in straight continuous walls having no openings, the spacing shall not exceed the values in Table-1.

Control Joints should always be provided at the following locations:

- At major changes in wall height
- At changes in wall thickness (other than at piers)
- At control joints in floor and roof slabs
- At T-junctions.

Table-1 Spacing of Contraction Joints for Unreinforced Masonry Walls

Masonry wall construction and surface finish	Maximum joint spacing (m)
External masonry that is face-finished, rendered and/or painted	7.0
Internal masonry that is face-finished or sheeted	6.0
Internal masonry that is rendered and/or painted	5.0
External masonry with openings more than 900 mm in height	5.0

Shrinkage experienced by concrete blocks and the presence of thermal movement are the main reasons behind cracking, hence the emphasis surrounding the necessity of control joints. The joints must also be thoroughly cleaned out and be of sufficient width to allow the blocks to move freely.

According to AS 3700, control joints should be built into unreinforced concrete masonry walls at all points of potential cracking, but in no case greater than 7m spacing in articulated residential construction. The location of control joints will vary, however, they can be positioned behind down pipes or above/below windows or door openings. Control joints must confine the full length of the wall to the footing.

It also must be noted that control joints must be added to the subsequent render to minimise the chance of cracking and other modes of failure. Generally, control joints in render should:

- Carry through with the control joints made in the underlying structure.
- Be made wherever rendering of the surface stops
- Be made where the rendering material makes contact with different materials or substrates such as wood, metal, concrete or panelling.
- Feature in areas of the structure which are likely to move.

Figure-1: Control Joint

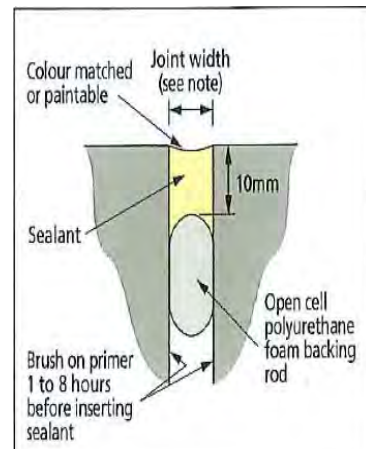
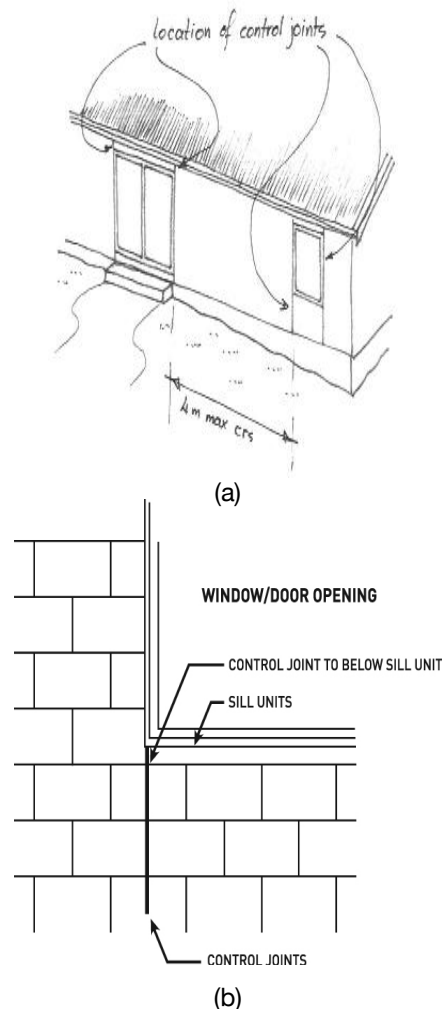


Figure-2: Typical Locations of Control Joint



1.2 Render

Render has grown in popularity due to the different surface textures, finishes, colours and products available. When done correctly, it provides an elegant look to residential facades and partitions. It also improves the fire rating of an already solid block wall while additionally providing a water proof coat.

Application techniques have generally stayed the same, though new products and finishes now available on the market have required the renderer to broaden their trade knowledge. The aesthetic purpose of render is to provide a straight surface branding the desired finish.

Unfortunately, rendering failures can happen for a number of reasons. And when it happens, even to the smallest degree, results can be unsightly.

1.2.1 Cement render

Cement render is the standard and most commonly associated product with the trade. It is the oldest existing form of rendering and is used in most parts of the world. It provides facades with the most basic of finishes yet with modern design trends, achieves a sleek and smooth surface.

Cement render is generally very rigid so it is advised that the builder remain vigilant and knowledgeable about the site conditions. This can be done by establishing whether there are hazards that can affect the final rendering work.

Render mixes usually comprise of sand, cement, lime and relevant admixtures for improved workability and adhesion. Important information about each of the components is listed below:

- **Cement:** Cements complying with AS 3972 should be used in the mixture, which usually come in the form of Type GP (General Purpose Portland) and GB (General Purpose Blended).
- **Sand:** Care should be taken with what sands are chosen for the mix as not all are suitable for use in rendering applications. In general, course graded

sands are used for undercoats while finer grades are used for finishing. Regardless all sands used must comply with AS 2758.1

- **Water:** Water should be clean and free from impurities. Mains water is normally satisfactory.
- **Admixtures:** Admixtures used for rendering applications should comply with AS1478 where applicable and be used strictly in accordance with the manufacturer's specifications. Though admixtures are not required for render, it is commonly used to improve the workability and technical properties of the mud batch. Care must be taken when choosing to use such additives as overdosing may cause detrimental effects to the strength and bonding properties of the render mix.
- **Pigments:** Pigments added to the mix should not exceed 10% of the mass of cement in the mix. A sample mix should be made, applied and allowed to dry to ensure the desired colour is achieved.

1.2.1.1 Render batching and mixing

Render mixes should be formulated in accordance to the type of substrate in which it is to be applied to. It can also be mixed either manually or using a mechanical mixer. The use of a mechanical mixer offers consistency to the mixing process as opposed to mixing it in a wheelbarrow or on a board.

For concrete block surfaces a cement:lime:sand ratio of 1:1:6 is applicable. When mixing by hand, it is important to combine and blend all the dry material prior to slowly adding the water. A crater or well should be formed whenever water is to be added. Mixing and turning should continue until all the sand is uniformly coated with a paste.

The opposite method is used for mechanical mixers, where about a litre of water is poured into the drum for priming before adding the dry components (in order of sand, cement and lime). Water then can be added thereafter where needed.

The end result for both methods should be a stiff, consistent mix that will sit up on a trowel.

1.2.1.2 Application

The surface must be cleaned of any laitance, paint, oil, dust and any dirt or loose material which will prevent a good bond forming between the mud and substrate. Any proprietary bonding agents can be applied at this stage as per manufacturer's specification.

After the initial preparation is performed, the wall must be dampened and the surface allowed to dry immediately before rendering. This is very important as concrete masonry absorbs moisture at a very high rate.

In most jobs, one or two coats of render are sufficient. Render that has been prepared must be used within half an hour of mixing. The most common application tools used are the trowel and hawk, though the application of texture coatings may also see the use of brush or rollers.

There are a number of different coats that can be performed before the job is complete, but the coats that mostly apply to concrete masonry are listed below;

- **Dash coat:** This coat is flicked onto the background in order to provide a rough finish for the subsequent render.
- **Undercoat:** The undercoat, sometimes known as scratch coat, is applied to provide the thickness. Once the render firms it should be raked or scratched (usually with a wire brush) to provide a key for the next coat. The thickness of undercoats should lie between 10mm-15mm.
- **Internal final coat:** The internal final coat usually dictates the finish of the surface. The thickness should not exceed 10mm over the undercoat.

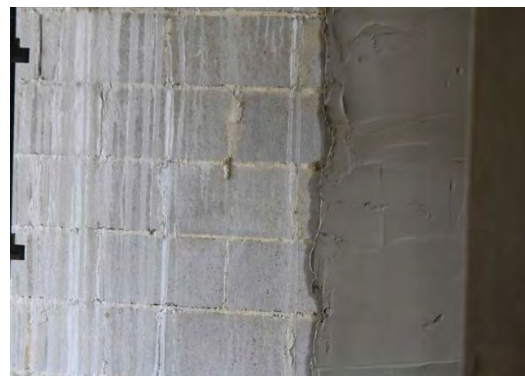
Once the final coat has been aligned and levelled, a setting coat made of lime putty and hardwall plaster may also be laid on with a trowel and skimmed with a long float to flatten the surface.

In traditional cement render, the finishes rarely fall outside trowelled or sponged finish. On external walls, the most popular finish is sponged (or sponge float) because it leaves the wall with a nice textured finish which is smoother when the sand is finer. Wooden or plastic floats are used either to prepare the surface for sponge finish or to skim the surface for tiling. It must be noted

when floating the wall, that the wall is kept moist using preferably a water gun on the mist setting or a bucket of water with a brush. The water should not be let to run down the wall.

The following pictures show the process of rendering a block wall.

Figure-3: Cement Render Coats



Step 1: Dash Coat (a)



Dash Coat (b)



Step 2: Under Coat (a)



Undercoat (b)



Step 3: Internal Final Coat



Step 4: Textured Finish

1.2.2 Acrylic Render

Acrylic render uses polymer modified base render mix which includes selected cement, carefully graded sands and a number of performance and workability enhancing additives. There are also additives available that can enhance the mechanical properties of the render which include weather and chemical resistance, flexibility and tensile adhesion.

It not only can be used for walls but is also used to render ceilings.

1.2.2.1 Batching and Mixing

Acrylic render usually comes pre-packaged. It may be desirable to mix additives to the water as per manufacturer's specifications. This will help with adhesion and will improve the acrylic properties of the render.

The best way of mixing this sort of render is using bucket and a drill mixer. It provides consistent results and since the render requires longer mixing times for the polymers and additives to react, is much less strenuous. About half the water needed to make the render should be emptied into the buckets, to minimise the probability of the render clumping at the bottom of the bucket. Next, add the remaining liquid slowly while mixing, until a creamy mixture is achieved. Apply render within half an hour of mixing.

1.2.2.2 Application

Acrylic render differs from traditional cement render as it dries quicker. Though a trowel and hawk is used to apply it, the work is performed in small runs. It is also applied, cut and floated (with a polystyrene or smooth plastic float) all within a run. The process is repeated until the length of the wall is completed.

There are also more layers that make up acrylic render. Where in traditional rendering the job can be done in usually no more than 2 coats, acrylic is done in about 3-5 if you consider a texture finish as part of the job.

These coats can come in the form of:

Scratch or skin coat- for uneven surfaces or old painted on render. A higher bond concentration is required in some cases.

Undercoat –to achieve a certain thickness, the undercoat must be performed in stages which involves apply, cut and float for each run.

Skim coat – in most cases, this coat is applied to provide a smooth finish which is the final coat. Acrylic render is seldom used as a base for tiling unless there are special conditions that require the product. Acrylic is also too costly to cover up.

Texture coat (optional) – There are many textured finishes in the market and it is best to have a fine coat (skim coat) as a surface. It further improves the waterproofing properties of a wall and gives a distinct finish. It may be also noted that it is one of the coats where application by trowel is not required. Depending on the desired finish, it can be rolled on, brushed, scratched and flicked on.

1.2.3 Curing and Protection

It is advised to avoid rendering in direct sunlight or high wind areas. Render should not be allowed to dry quickly. It should be noted that rendering a concrete masonry wall can require a much longer drying time than on clay masonry wall, and therefore the renderer may need to wait before applying the next coat. Keeping the render coats moist for 3 days after application ensures the mud is allowed to fulfil its maximum strength. It is also advised to protect fresh render with clear or lightly coloured plastic sheeting always remembering to prevent it from touching the render.

Section 2: Results of Defective Work

Both cement render and acrylic render can be an effective and durable external finish to buildings, but can suffer from a range of defects associated with its design and workmanship. Rendering defects can be related to a range of reasons beyond the defects attributable to construction design and operations, some of which are failure in render specification, inadequate background preparation and poor site practice.

Rendering defects occur within the coating itself or in the background. Background defects may be a cause of faults in rendering. Alternatively, a fault in render coating can lead to accelerated secondary failure in the wall. Defects may also arise as a result of incompatibilities between the render and the background. The common forms of render defect are cracking and peeling.

Cracking in rendering may be associated with partial detachment of render from the wall. Breaking away from the render surface increases the risk of water seepage from the outer face to the inner skin. By allowing water admittance to the back of the intact render coat, any weakness in the bond between render and background or between different render coats will result in further defects and a vicious circle will occur, producing rapid failure.

Shrinkage crack lines appear random and spread in all direction, like a web. It is caused by shrinkage of the render and commonly occurs when:

- rendering in hot dry and windy conditions
- using sand with excessive clay
- using strong render mixes.

Large-scale spalling may be due to loss of adhesion between the render and the background. Where water enters the interface between the remaining render and the wall, a progressive bond failure can occur.

Peeling is a large-scale form of flaking produced by differential movement. It can be caused by the final finish on its own, as a reaction to other background coatings or between render coating and substrate.

The next four pictures show typical render cracking and render peeling on concrete masonry walls.

Figure-4: Render Cracking

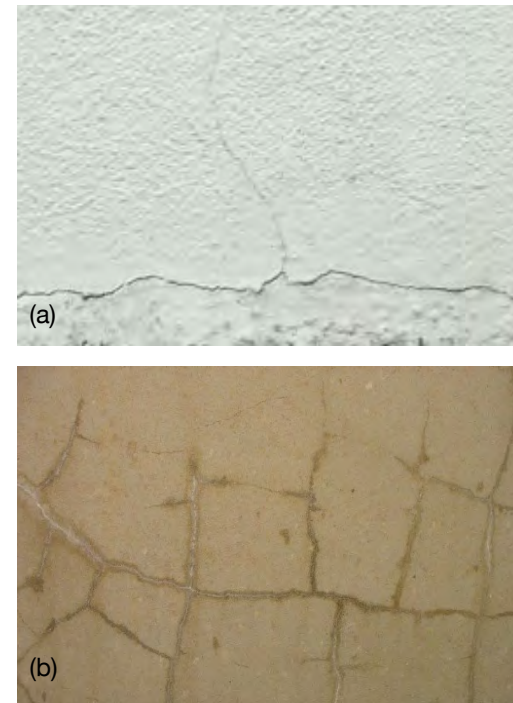


Figure-5: Render Peeling



Section 3: Diagnosis and Cure

There are many symptoms that indicate the occurrence of render failure. These can include:

- Cracks in the render which are not related to cracks in the wall.
- Areas where render has actually detached from the building.
- Pockets loose or mounds behind the render where partial detachment has occurred. This can be identified by a drummy or hollow sound when tapping the affected area.

It is imperative to investigate the reasons behind the symptoms before action is to be taken. The following considerations may shed light onto the probable causes:

- The type of construction
- The composition of render along with the number of coats
- If the wall is cavity insulated, did the failure relate to the time the cavity was insulated?
- Movement or settlement cracks in the building.
- Seepage of moisture in backing layers of the structure. This can promote sulphate expansion

which can be identified by whitish crystals on the surface of masonry. In colder climate it can also cause the moisture to freeze. The subsequent expansion will force the render coat off the wall.

- Examine the surface of the back wall, the finish to the backing coats and the fixing and condition of any render reinforcement.
- Evidence that the bond or key has failed. Record areas affected by cracking and detachment and survey remaining areas for hollowness or bulges that suggest more widespread problems.

There are really only two cures for rendering problems and they are:

- Patching up the affected area
- Completely replacing the rendering

The path taken for repair depends on what caused the problem in the first place. If the cause was related to application or dampness then the repair can be restricted to the affected area only.

Problems caused by unsuitable materials or wrong specification may warrant the complete replacement of the rendering as the majority of areas may be suspect. The render can also be overlaid to keep the wall dry.

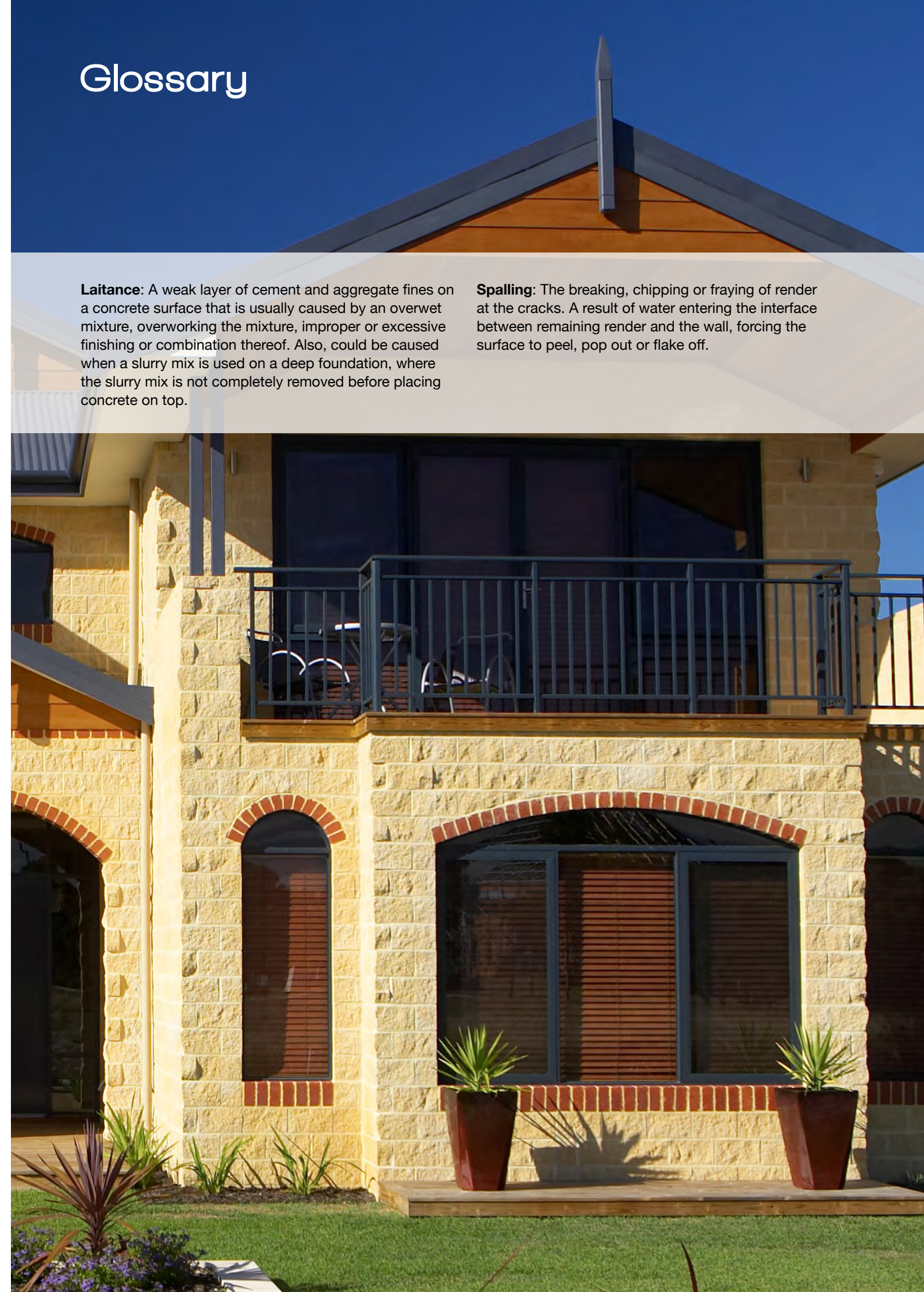
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2. Brikmakers, *Control Joints*, Viewed 23 May 2013, from http://brikmakers.com/docs/control_joints.pdf
3. Carllion S, *Defects in Buildings: Symptoms, Investigation, Diagnosis and Cure*, The Stationery Office Books Press, London, 2005.
4. *Concrete Data-Render*, Cement and Concrete Association of Australia.
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6. Geoff C & John H, *The Technology of Building Defects*, Taylor & Francis Press, 2003.
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8. *NCC 2013 Building Code of Australia-Volume Two*, Australian Government and States and Territories of Australia, 2013.

Glossary

Laitance: A weak layer of cement and aggregate fines on a concrete surface that is usually caused by an overwet mixture, overworking the mixture, improper or excessive finishing or combination thereof. Also, could be caused when a slurry mix is used on a deep foundation, where the slurry mix is not completely removed before placing concrete on top.

Spalling: The breaking, chipping or fraying of render at the cracks. A result of water entering the interface between remaining render and the wall, forcing the surface to peel, pop out or flake off.



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