

Keystone®

RETAINING WALL SYSTEMS

SOUTH & NORTH QUEENSLAND

**NM NATIONAL
MASONRY**
MAKERS OF FINE BLOCKS & PAVERS



Contents

RETAINING WALL SYSTEMS



Product Disclaimer

Concrete Blocks, Bricks, Pavers and Retaining Wall products supplied by National Masonry are manufactured using raw materials that inherently vary in nature. Whilst all effort is made to produce uniformity in our range of products, variation in colour, texture, and finish can be present. The dimensional characteristics of all products are nominal and variations in length, height, and width can occur from unit to unit which needs to be taken into consideration when installing these products.

1. Colours other than stock colours are made to order. Contact your nearest National Masonry office for your area's stock colours.
2. Colour and texture variation. The supply of raw materials can vary over time. In addition, variation can occur between product types and production batches.
3. We reserve the right to change the details in this publication without notice.
4. For a full set of Terms and Conditions of Sale please contact your nearest National Masonry sales office.
5. Please consult with your local Council or Shire for design regulations prior to the construction of your wall. BCA (Building Code of Australia) or local governing bodies in general require those walls over 15 metre in height and/or where there is loading such as car or house near the wall be designed and certified by a suitably qualified engineer.
6. Tables within this publication are offered as a guide only and should not be accepted as a certified design.
7. Maximum wall heights disclaimer:
The gravity wall heights are maximum heights calculated in accordance with CMAA MA-53 Appendix D guidelines and a qualified engineer should confirm the suitability of the product for each intended application. As such, due consideration must be given to but not limited to:
 - Cohesion,
 - Dry backfill: no ingress of any water into the soil behind the retaining wall,
 - All retaining walls are designed for zero surcharge unless noted otherwise.

These walls are intended for structure Classification A walls only as defined in AS4678 Earth Retaining Structures as being where failure would result in minimal damage and/or loss of access.

Contents

Product Notes & Disclaimer	
Keystone® Specifications.....	2
Benefits & Applications.....	3
Geogrid Soil-Reinforced Wall Construction Guidelines	4
No-Fines Concrete Wall Construction Guidelines.....	5
No-Fines Concrete Construction Steps	6
Gravity Wall Selection.....	6
Gravity Wall Construction Guidelines	6

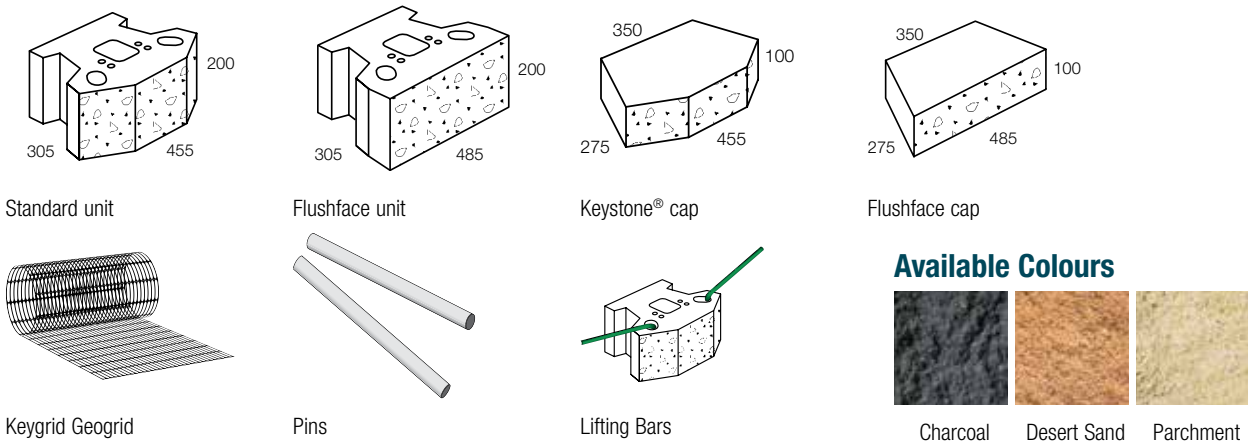
About National Masonry

The National Masonry story began with the acquisition of Boral Masonry's Mackay operation in April 2012 and continues to grow with the acquisition of Boral Masonry's South Queensland and Victorian operation in January 2013. National Masonry retains the heritage of expertise and industry credentials and combine these with the flexibility and innovative foresight of an independent privately owned company. Our customers will benefit from dealing with the same great people, same great products and services, and a new vision for the future.

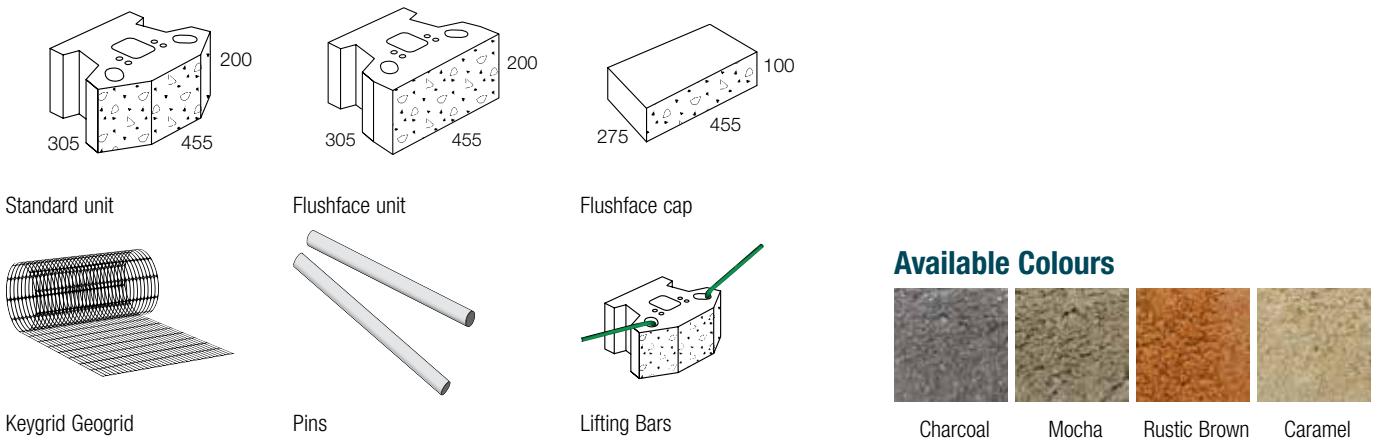
National Masonry, the new benchmark in Masonry.



Keystone[®] Specification table - SQLD



Keystone[®] Specification table - NQLD



Keystone[®] Specification table - SQLD

Type	Max Wall Height	Units per sq metre	Units per pallet	Weight per unit (kg)
Standard Unit		11	45	32
Flushface Unit	(up to 12m with engineering)	10.3	45	37
Standard Cap		2.2 (per lineal metre)	90	24.6
Flushface Cap		2.06 (per lineal metre)	90	24.6
Pins	2 pins per full unit (high strength pultruded fibreglass)			
Lifting Bars	Keystone [®] units should be lifted by two people using the Keystone [®] lifting bars.			
Geogrid	As per design requirements			

Keystone[®] Specification table - NQLD

Type	Max Wall Height	Units per sq metre	Units per pallet	Weight per unit (kg)
Standard Unit		11	36	36.8
Flushface Unit	(up to 12m with engineering)	11	36	41.3
Flushface Cap		2.2 (per lineal metre)	50	27.0
Pins	2 pins per full unit (high strength pultruded fibreglass)			
Lifting Bars	Keystone [®] units should be lifted by two people using the Keystone [®] lifting bars.			
Geogrid	As per design requirements			



Keystone® Engineered Segmental Retaining Wall System

Benefits:

- Durable
- Allows for design creativity and flexibility
- Ease and speed of construction
- Cost competitive
- Versatile
- Clean neat finish
- Strong strength to weight ratio
- Construction methodology
- Blends into environmental landscape
- RTA, QTM, VIC Roads approved walling system

Applications:

- Low height gravity walls
- Geogrid soil reinforced up to 15m height
- Stream and drainage channels
- Wing walls
- Embankment stabilisation
- Terraced walls
- Geogrid – reinforced soil retaining structures

Construction/Design:

- Vertically with curves as tight as 1m radius (standard unit only)
- Set-back
- Straight or curved walls
- 90 degree corners
- Stairs

Blocks:

- Standard unit
- Flushface unit

Geogrid Soil-Reinforced Wall Construction Guidelines

For taller, more critical walls, the combination of Keystone® units with geogrid soil reinforcement allows walls to be built to heights up to 15m, without costly structural footings. When placed between layers of compacted soil, geogrids create a reinforced soil mass, which essentially acts as a larger gravity wall structure.

Geogrids can be used with most existing site-soils and are generally not affected by water, micro organisms, alkali or acidic soils. Consult with your engineer for design requirements of Keystone® walls using geogrid soil reinforcement.

NOTES:

- Table 1 is prepared as per AS4678 : 2002. Suitability of the information contained in the table must be referred to a qualified professional engineer. These tables are supplied as a guide, and do not form any part of any contract with the user.
- Table 1 is based on foundation material with minimum 200kPa bearing capacity.
- Where site conditions and loadings vary from those in the table, professional engineering advice should be obtained.
- The minimum embedment of wall below ground level is assumed to be H/20 or 100mm, whichever is greater.
- The length of the 15° backfill slope is assumed to be equal to the height of wall, H.

Table 1 - Maximum Wall Heights for Geogrid Soil-Reinforced Walls

Surcharge	Wall Height H (m)	Geogrid Layers	Geogrid Height Above Leveling Pad							Geogrid Length L (m)		
			Layers							Soil Type (phi)		
			1	2	3	4	5	6	7	25	30	35
10 Degree or 5 Degree	1.1	2	0.2	0.8	-	-	-	-	-	1.5	1.5	1.5
	1.5	3	0.2	0.8	1.2	-	-	-	-	1.9	1.5	1.5
	1.9	3	0.4	1.0	1.6	-	-	-	-	2.1	1.8	1.6
	2.3	4	0.2	0.8	1.4	2.0	-	-	-	3.4	2.1	1.8
	2.7	5	0.4	0.8	1.2	1.8	2.4	-	-	3.9	2.4	2.1
	3.1	6	0.2	0.6	1.0	1.6	2.2	2.8	-	4.8	2.8	2.4
5kPa Driveway	1.1	2	0.2	0.8	-	-	-	-	-	1.5	1.5	1.5
	1.5	3	0.2	0.6	1.2	-	-	-	-	1.9	1.5	1.5
	1.9	3	0.4	1.0	1.6	-	-	-	-	2.2	1.8	1.6
	2.3	4	0.2	0.8	1.4	2.0	-	-	-	2.5	2.0	1.8
	2.7	5	0.2	0.4	1.2	1.8	2.4	2.4	-	2.8	2.6	2.1
	3.1	6	0.2	0.6	1.0	1.6	2.2	2.2	-	3.2	2.6	2.4

* Geogrid with $T_u=55\text{kN/m}$ *Geogrid lengths for 5kPa driveway are based on the load being applied a minimum of 800mm from the face of the retaining wall.

For full construction steps refer to www.nationalmasonry.com.au

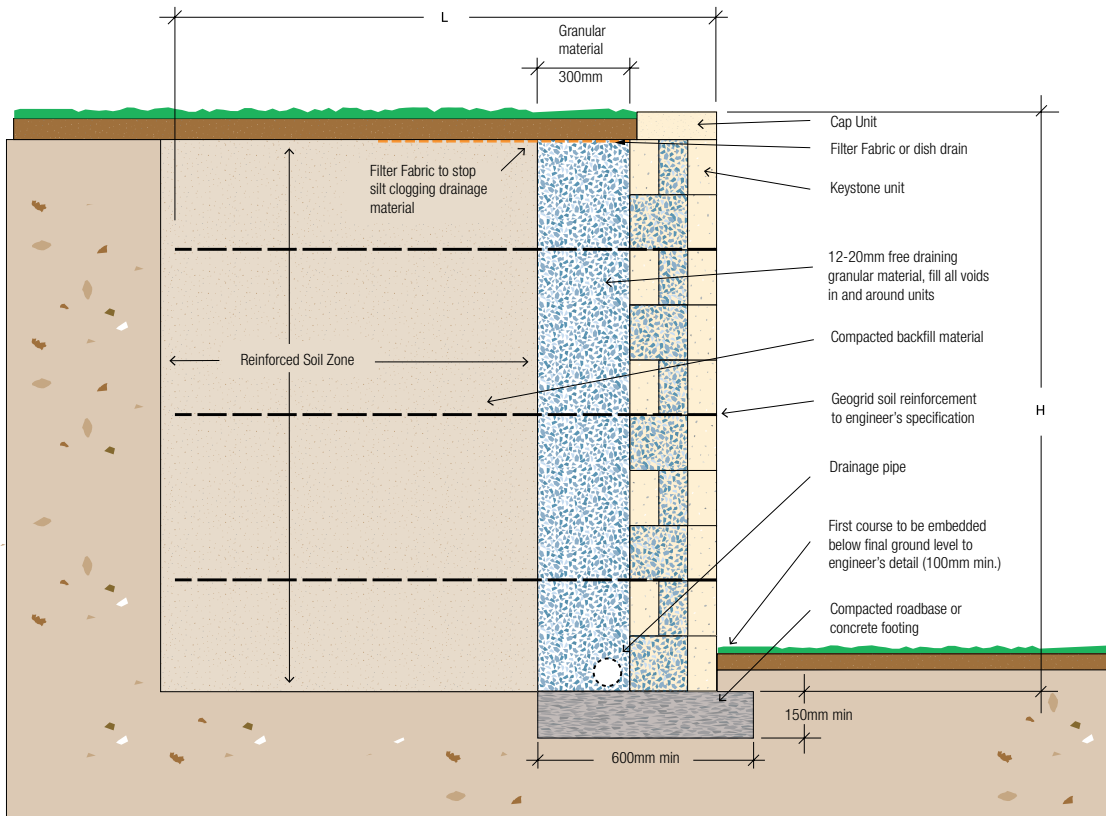


Figure 1 - Typical Construction Detail - Keystone® Geogrid Reinforced-Soil Wall



No-Fines Concrete Wall Construction Guidelines

The No-Fines Concrete backfill system increases the mass of Keystone[®] retaining walls allowing maximum heights in Table 2 to be (achieved / attained/ reached) without using geogrids.

This is ideal for boundary walls where the geogrids would otherwise cross into the neighbouring property.

No-Fines Concrete shall consist of cement, water and coarse aggregate. Cement will comply with the definitions for cement per AS3972 : 1991 -

'Portland and Blended Cements'. The quantity of cement is specified as 210kg/m³ with a total water/cement ratio of between 0.45 and 0.55.

The particle size distribution of the aggregate shall comply with the limitations for the nominal single sized 20mm aggregate specified in AS2758.1. Table 2 is prepared as per AS4678 : 2002, and is based on a 5kPa surcharge loading at the top of the wall. This table is supplied as a guide, and does not form any part of any contract with the user.

- The maximum slope of the backfill behind the wall is to be 5% (1 vertical to 20 horizontal).

NOTES:

- 15MPa No-Fines Concrete with a 6:1 ratio (Gravel : Cement).
- The density of this product will vary with the density of the aggregate used. The density range may be from 1800kg/m³ to 2100kg/m³. (Table based on density of 2100kg/m³.)
- The void ratio of the mix is expected to be between 20% and 30% and should be free draining.
- This product has no slump and exerts similar pressures on the soil and formwork, as does loosely poured aggregate.
- Global stability considerations should be checked by an engineer especially in poor clay conditions.
- Design assumes a dry excavation (i.e. water table is below bottom of footing level). If ground water appears in the excavation, the wall is to be re-designed by a suitably qualified engineer.

Table 2 - Maximum Wall Heights for No-Fines Concrete Wall Construction

Wall Height 'H' (mm)	Retained Soil CLAY $\phi = 26^\circ$ (POOR) 'T' (mm)	Retained Soil SAND $\phi = 30^\circ$ (AVERAGE) 'T' (mm)	Retained Soil GRAVEL $\phi = 34^\circ$ (GOOD) 'T' (mm)
1000	550	500	450
1400	750	700	650
1800	1050	1000	850
2200	NA	1250	1000
2600	NA	1350	1200

ϕ Denotes the internal angle of friction of the retained material

If material below No-Fines Concrete is of poor quality, then the material must be replaced with a 150mm thick layer of crushed sandstone

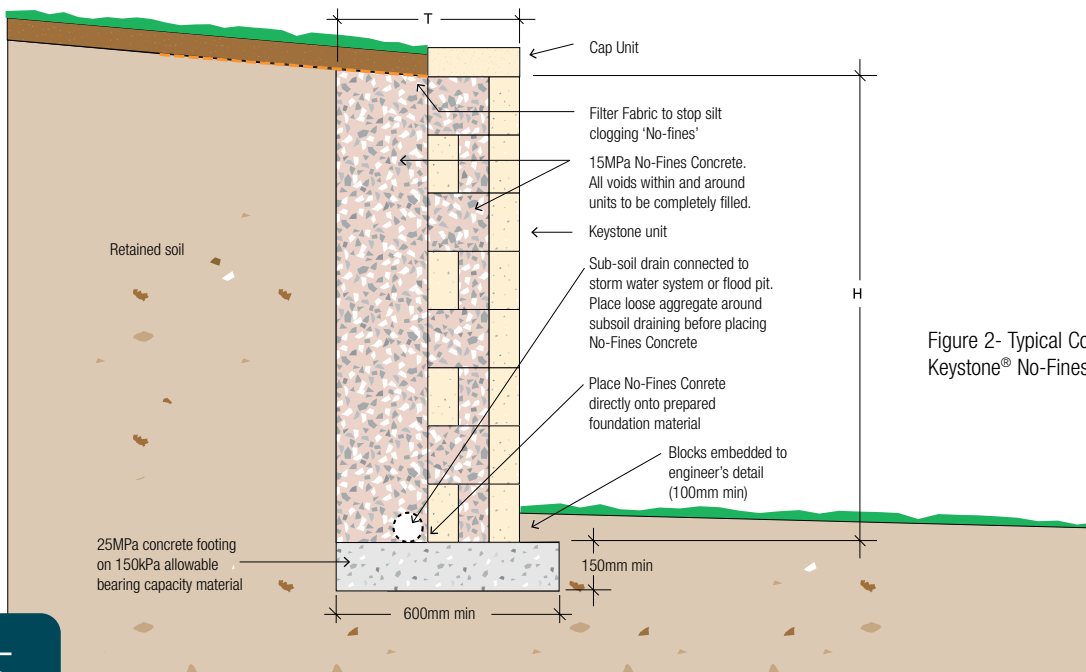


Figure 2- Typical Construction Detail - Keystone[®] No-Fines Concrete Mass Gravity Wall

No-Fines Concrete Construction Steps

STEP 1: Excavation/Preparation of Levelling Pad

Excavate a trench 600mm wide and sufficiently deep to allow a levelling base of 150mm +25mm height for each course. Place 25MPa concrete (non-reinforced) to form the footing.

STEP 2: Installing the First Course

Lay the first course of units side to side over the prepared base, with the 12mm pinholes on top. Maintain the required distance between pinhole centres of adjacent units. In straight walls, units will touch. In concave or convex curves, the units will overlap or require spacing to maintain the required pin distance.

STEP 3: Installing the Pins

Place two high strength fibreglass connecting pins into each unit. Use the front holes for a vertical wall (corners and curved walls). Use the rear holes for a 1 in 8 setback (i.e. for every course the wall will set back 25mm). For straight walls only.

STEP 4: Additional Courses

Sweep the top of the previous course of units clean of any loose gravel. Place the next course of units so that the kidney holes fit over the pins of the two units below. Pull the unit towards the face of the wall until it locks with the pins on both sides. Repeat steps 3 and 4.

STEP 5: No-Fines Concrete Backfill

Backfill the wall with No-Fines Concrete. All voids inside and between the units must also be filled. The vertical height of any pour of No-Fines Concrete is limited to 600mm. Each pour must be allowed to harden prior to pouring the next lift. Alternatively the wall may be propped.

STEP 6: Installing Capping Units

Lay capping units, backfill and compact to required grade. It is recommended that the capping units be secured using masonry construction adhesive or epoxy cement.

Gravity Wall Selection

For low, non-critical walls, (i.e. walls covered in the table below) the Keystone[®] Retaining Wall System is effective as a gravity wall structure, utilising their weight and interaction of the units to resist earth pressures.

Retained Soil Descriptions

Poor Soils	Include fine sands, gravelly clays, sandy clays, silty sands. Angle of internal friction $\geq 25^\circ$
Average Soils	Include well graded sands, gravelly sands. Angle of internal friction $\geq 30^\circ$
Good Soils	Include gravels, sandy gravels, crushed sandstone Angle of internal friction $\geq 35^\circ$

Table 3: Refer to Point 7: Maximum wall heights disclaimer on the back page of this brochure. The gravity wall heights are maximum heights calculated in accordance with CMAA MA-53 Appendix D guidelines and a qualified engineer should confirm the suitability of the product for each intended application.

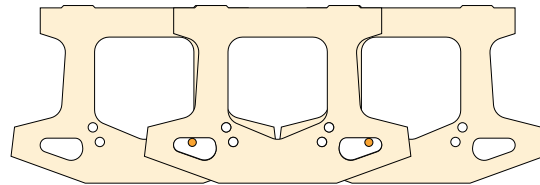
Surcharge Loading	Backfill Type	Wall Height H (mm)	
		Vertical	1 in 8 Setback
No Surcharge Loading	Poor	800	900
	Average	900	1000
	Good	1000	1200
15° Sloped Backfill	Poor	600	900
	Average	700	900
	Good	800	1100
Driveway/Carpark Loading (6kPa)	Poor	400	500
	Average	500	600
	Good	600	800

Gravity Wall Construction Guidelines

Setback Options

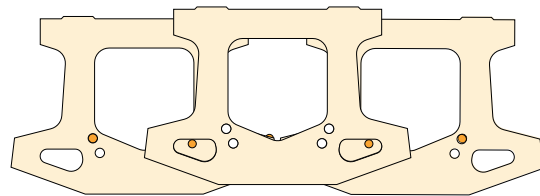
- Two sets of pin holes are provided in Keystone[®] units.
- For vertical construction, install pins in the front holes.
- For 1 in 8 setback construction, install pins in the back holes.
- Vertical installation must be used when designing walls with curves or corners.

(The vertical Keystone wall has a slight batter 1:40 approx. to allow for post construction movement).



Install pins in front holes for near vertical walls

OR



Install pins in rear holes for 1:8 setback walls

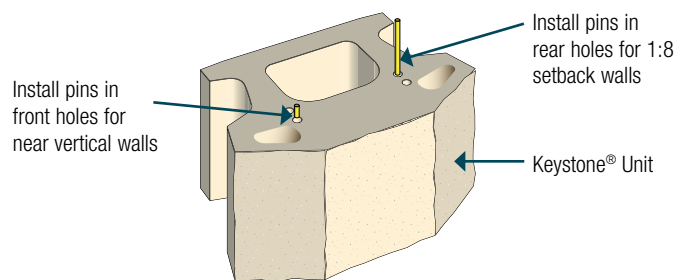


Figure 3 — Installation of Pins

South Queensland

62 Industrial Avenue,
Wacol

Brisbane Qld 4076
Phone: (07) 3271 9292
Fax: (07) 3271 1815

North Queensland

6 David Muir Street,
Slade Point

Mackay Qld 4740
Phone: (07) 4955 1155
Fax: (07) 4955 4130

Gold Coast

663 Pine Ridge Road,
Biggera Waters

Gold Coast Qld 4216
Phone: (07) 5552 3300
Fax: (07) 5552 3399

Victoria

Riding Boundary Road,
Deer Park

Melbourne Vic 3023
Phone: (03) 9363 6400
Fax: (03) 9363 6008

To find your closest **National Masonry** stockist,
to receive brochures or to learn more about our products,
call us or visit our website at **www.nationalmasonry.com.au**

Colour variations occur from batch to batch. Colours shown are indicative only and should not be used for final selection. Products ordered should be chosen from actual samples current at the time of order and are subject to availability. Photographs in this brochure are only representative of National Masonry products and the appearance and effect that may be achieved by their use. Samples, brochures and displays should be viewed as a guide only. Customers should ensure all delivered products are acceptable, and any concerns about products are made prior to laying. All prices are subject to availability and can be withdrawn or varied without notice.

© Copyright National Masonry Pty Ltd— all rights reserved 2013.
Gardenwall® & Keystone® are registered trademarks of Keystone® Retaining Wall Systems Inc, use under licence by National Masonry. National Masonry, the National Masonry logo, nationalmasonry.com.au, if these and other National Masonry Pty Ltd trade marked terms are marked on their first occurrence in this information with a trade mark symbol (® or ™), these symbols indicate Australian registered or common law trade marks owned by National Masonry Pty Ltd at the time this information was published. Such trade marks may also be registered or common law trade marks in other countries. Other product, company or service names may be trade marks or service marks of others. National Masonry Pty Ltd ABN 94 155 064 136. Correct as at May 2014.