

5.2 Concrete Bricks and Wall Ties

Bond Tests

Information on the bond strength characteristics of concrete bricks was required by the Standards New Zealand Committee revising NZS 4210. In addition, the matter of pull values for ties particularly with regard to the reduced embedment lengths for 70 mm veneer needed to be investigated.

The bond strengths and pull-out strengths achieved are seen as compatible with both standard veneer and reduced thickness veneer construction. The tests were carried out by the New Zealand Concrete Research Association in accordance with NZS 4210 requirements for bond strength test. The pull-out test was developed to measure the outline performance characteristics listed in NZS 4210.

The pull-out test method used has now been superseded by the requirements of AS/NZS 2699. For more recent tests on pull-out tests undertaken to AS/NZS 2699 reference should be made to BRANZ publications:

- (i) Critical properties of mortar for good seismic performance of brick veneer by S. J. Thurston. BRANZ Study Report, SR 258 (2011)
- (ii) Investigation of the Strength and Stiffness of Dry-bedded Ties in Various Veneer Types by G. J. Beattie. BRANZ Study Report No. 152 (2006).

However, the basic premise of the comparison between the two different mortar strengths remains valid.

Bond Tests, Concrete Bricks: Summary of Findings

Brick Type	Laying Condition	Mortar Type	Recorded Bond Strength	Mean of 5 Bond (kPa)
Solid	Dry	Rich ¹	761-1078	900
	Dry	Lean ²	411-789	562
	Pre-moist	Rich	557-737	642
	Pre-moist	Lean	297-529	404
Holed	Dry	Rich	537-1029	776
	Dry	Lean	430-757	573
	Pre-moist	Rich	672-1020	802
	Pre-moist	Lean	453-659	558

Note:

- ¹ 1:3 by volume
- ² 1:5 by volume

The simple bending stress within a one way spanning panel based on 600 mm x 400 mm is 82 kPa for 87 mm brick and 102 kPa for 70 mm brick.

Tie Pull-out Tests, Concrete Bricks: Summary of Findings

(All units laid dry with 25 mm x 1.5 mm standard galvanized crimped steel tie).

Brick Type	Mortar Type	Tie Embedded (mm)	Pull-out Loads (kN)	Mean of 5 Pull-out (kN)
Solid	Rich	60	5.2 - 6.4	5.7
		45	4.1 - 5.3	4.8
	Lean	60	3.2 - 7.1	5.4
		45	3.3 - 5.3	4.5
Holed	Rich	60	8.5 - 9.1	8.8
		45	5.0 - 7.0	6.1
	Lean	60	4.1 - 6.7	5.4
		45	4.0 - 5.4	4.7

The horizontal design load for a tie as per NZS 4210 is to be taken as twice the area of dead load held by the tie. For 87 mm wide concrete brick with tie spacing at the maximum permitted (600 mm x 400 mm) the design load is 0.82 kN and for 70 mm wide concrete brick 0.66 kN.

NZS 4229/E2AS1/E2AS3

There has been a recent (2012) review of the spacing/specific requirements for ties due to changes in the requirements of the loading code AS/NZS 1102. The latest requirements can be found in **Tables 1 and 2** (next page). This information was provided by the Department of Building and Housing

The durability requirements can be summarized as follows, although reference to NZS 3604, to determine the actual zone boundaries, is required. Broadly, the sea spray Zone R4 extends from the high tide water mark up to 500 metres inland. Ties in this zone are required to be stainless steel 316 or 316L grade. Elsewhere ties need to have 470 g/m² galvanised coating or they could be stainless steel to 304 grade.

See more durability details in Section 5.1.

Special requirements are needed for geothermal areas.

Table 1: Masonry Veneer Area/Tie

Earthquake Zone	Area of masonry veneer attached to each Type B veneer tie of the duty specified. (m ²)					
	Veneer less than 180 kg/m ²			Veneer 180 kg/m ² to 220 kg/m ²		
	EL	EM	EH	EL	EM	EH
1	0.24	0.24	0.24	0.20	0.24	0.24
2	0.16	0.24	0.24	0.13	0.20	0.24
3	0.11	0.16	0.24	0.09	0.13	0.24
4	0.08 ⁽⁶⁾	0.12	0.23	0.07 ⁽⁶⁾	0.11	0.22

- (1) The horizontal tie spacing multiplied by the vertical tie spacing selected must equal or be less than the area of masonry veneer given for the earthquake zone and the veneer mass. The maximum spacing of ties is 600 mm horizontal and 400 mm vertical.
- (2) Type B and prefix E indicate ties are manufactured to meet the testing conditions set out in AS/NZS 2699.1.
- (3) L (light), M (medium) and H (high) indicate strength capabilities of ties to meet the testing conditions set out in AS/NZS 2699.1.
- (4) Using high strength ties does not permit the maximum spacing of ties to be increased.
- (5) Ties may be face fixed to blockwork or fully embedded in the structural masonry wall joint.
- (6) Some small veneer areas may be impracticable.
- (7) Minimum strength for fixings to blockwork are 0.5 kN (EL), 0.75 kN (EM) and 1.5 kN (EH).

Table 2: Tie Duty Schedule

Earthquake Zone	Masonry veneer attached by Type B veneer ties of the duty and spacings specified	
	Veneer less than 180 kg/m ²	Veneer 180 kg/m ² to 220 kg/m ²
	Spacing 600 mm x 400 mm	Spacing 500 mm x 400 mm
1	EL	EL
2	EM	EM
3	EH ⁽⁶⁾	EH ⁽⁶⁾
4	SED ⁽⁶⁾	EH

- (1) Maximum spacing of ties with veneer less than 180 kg/m² and for SED is 600 mm by 400 mm. SED means actual spacing of ties is to be determined by specific engineering design.
- (2) Maximum spacing of ties with veneer between 180 kg/m² and 220 kg/m² is 500 mm by 40 mm.
- (3) Type B and prefix E indicate ties are manufactured to meet the testing conditions set out in AS/NZS 2699.1.
- (4) L (light), M (medium) and H (high) indicate strength capabilities of ties to meet the testing conditions set out in AS/NZS 2699.1.
- (5) Using high strength ties does not permit the maximum spacing of ties to be increased.
- (6) Ties may be face fixed to blockwork or fully embedded in the structural masonry wall joint.
- (7) Minimum strength for fixings to blockwork are 0.5 kN (EL), 0.75 kN (EM) and 1.5 kN (EH).

Copyright and Disclaimer

© 2010 New Zealand Concrete Masonry Association Inc.

Except where the Copyright Act and the Limited-License Agreement allows otherwise, no part of this publication may be reproduced, stored in a retrieval system in any form or transmitted by any means without prior permission in writing of the New Zealand Concrete Masonry Association. The information provided in this publication is intended for general guidance only and in no way replaces the services of professional consultants on particular projects. No liability can therefore be accepted, by the New Zealand Concrete Masonry Association, for its use. For full terms and conditions see <http://www.nzcma.org.nz/manual.html>.