BRANZ

BULLETIN

ISSUE562

LOW RETAINING WALLS

August 2013

This bulletin provides guidance for builders, designers and building owners on the construction of retaining walls that are less than 1.5 m in height and are not subject to surcharges or additional loads.

All retaining walls must be constructed to comply with the requirements of the New Zealand Building Code but do not require a building consent if retaining less than 1.5 m and are not subject to surcharges or additional loads.

Low retaining walls may be subjected to high forces acting upon them, and the correct steps must be followed to ensure their stability. This bulletin updates and replaces Bulletin 394 of the same name.

1.0 SCOPE

1.0.1 Low retaining walls covered in this bulletin are those exempt from the need to obtain a building consent. These are described in clause 1(c) of Schedule 1 'Exempt building work' to the Building Act 2004 as "any retaining wall that retains not more than 1.5 metres depth of ground and that does not support any surcharge or any load additional to the load of that ground (for example, the load of vehicles on a road)".

1.0.2 While a building consent is not required, the wall must comply with the requirements of the Building Code. Functional requirement B1.2 of Building Code clause B1 *Structure* states: "Buildings, building elements and sitework shall withstand the combination of loads that they are likely to experience during construction or alteration and throughout their lives." Walls must also comply with the requirements of B2 *Durability* and F4 *Safety from falling*.

1.0.3 The loads imposed, even on low retaining walls, can be complex and can vary with the type of ground, the water content of the soil and surcharge loads (Figure 1). Retaining walls excluded from this bulletin are those:

- retaining more than 1.5 m of soil
- supporting surcharge or load, including loads:
  - imposed on the ground by a building above the wall
  - imposed by vehicles
  - imposed by sloping backfill above the wall
- built on or supporting expansive soils, peat or very weak soil
- where the water table is within 500 mm of the underside of the wall foundation
- built where there is likely to be instability due to steep ground falling away from the toe of the wall
- built without drainage to prevent water build-up behind the wall.

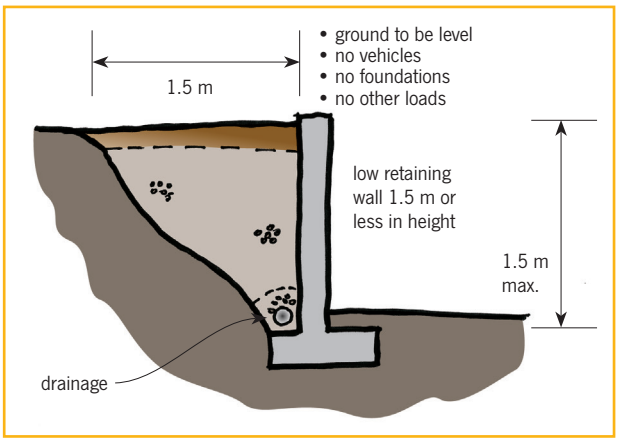

Figure 1. Restriction on superimposed loads.

1.0.4 In all the exclusion instances specified in paragraph 1.0.3 above, obtain the advice of a chartered professional engineer.

1.0.5 This bulletin updates and replaces Bulletin 394 of the same name.

2.0 DESIGN CONSIDERATIONS

2.1 SOIL TYPES

2.1.1 Major factors affecting the stability of a retaining wall are the type of soil it supports, the backfill material and the type of soil it is founded on. An early assessment must be made of the soil type of the subgrade and the soil to be retained.

2.1.2 Topsoil is a surface layer consisting mostly of decayed vegetable matter that is able to support plant life. Topsoil must be removed from under the foundations of all retaining walls.

2.1.3 Suitable subgrade materials beneath the topsoil may be:

- non-cohesive granular soils including gravels, sand, rock or any mixture of these types
- cohesive soils such as very stiff clay or gravelly clay.

2.1.4 Unsuitable subgrade materials are:

- very soft clays that, when wet, will extrude between the fingers when squeezed in the hand
- peat and similar organic soils
- made-up ground or fill topsoil, unless it has been specifically engineered and signed off as being suitable.

2.1.5 If in doubt about the suitability of the soil type, engage a chartered professional (geotechnical) engineer.

2.2 SELECTION

2.2.1 When building a retaining wall, consider:

- suitability for site and soil conditions – not all systems are suitable for all sites
- access to get materials to the wall location
- ease of construction
- cost
- appearance
- drainage and water table
- distance back from an adjacent slope.

2.3 BARRIERS

2.3.1 Performance requirement F4.3.1 of Building Code clause F4 *Safety from falling* states: "Where people could fall 1 metre or more from an opening in the external envelope or floor of a building, or from a sudden change of level within or associated with a building, a barrier shall be provided." (By definition, a retaining wall is a building.)

2.3.2 An exception to this requirement may be able to be applied where it is not possible for the top of the wall to be easily accessed.

3.0 GENERAL CONSTRUCTION

3.0.1 Successful construction requires good supervision, accurate setting out, firm, stable foundations and attention to maintaining safety when a wall is being constructed.

3.0.2 Where a proprietary system is to be used, inform the manufacturer/supplier of the dimensions and soil conditions around the proposed wall and obtain their detailed recommendations. Ensure that the wall is constructed strictly in accordance with those recommendations.

3.0.3 Most manufacturers' standard clauses have varying requirements for different soil types and may exclude some soil types such as expansive clay and peat.

3.0.4 When planning to use thick walls, such as crib retaining walls and mechanically stabilised embankments (MSE), pay careful attention to the space necessary to install the wall, as this can often require additional excavation. The whole wall, including excavation, retaining wall allowance for backward slope and drainpipe (perforated or draincoil), must be within the legal boundary.

3.0.5 Drainage must always be provided behind the wall to prevent the possibility of water pressure build-up.

3.0.6 Maintaining safety around a wall under construction can be assisted by:

- isolating the construction area with the use of temporary barriers and/or warning tapes
- covering holes until filled
- danger warning signs
- providing caps to any protruding reinforcing steel.

4.0 RETAINING WALL TYPES

4.1 MASS GRAVITY WALL

4.1.1 This type of wall depends on its weight, a low height-to-width ratio and a backward slope for its stability. Such walls may be constructed on a compacted base course in mass stonework or concrete or a combination of both (Figure 2). This type of wall is normally rigid – construction joints may be incorporated to improve tolerance of ground movement.

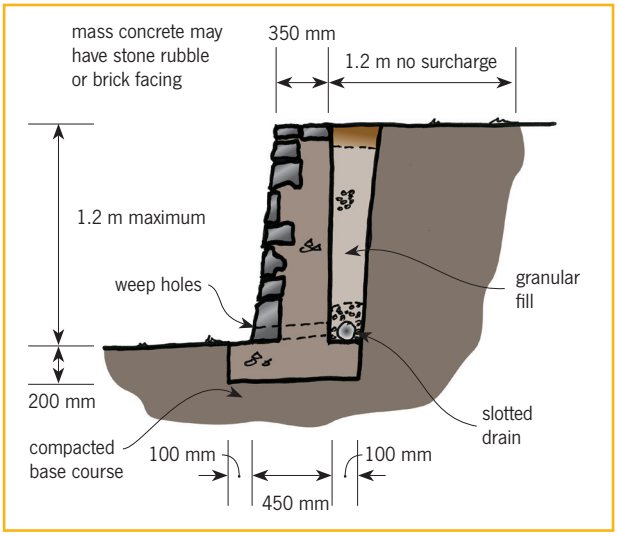

Figure 2. Mass concrete and rubble gravity retaining wall.

4.2 SEGMENTAL RETAINING WALL

4.2.1 Segmental retaining walls are constructed from precast concrete masonry blocks on a compacted base course or on an in situ concrete foundation (depending on the height and the manufacturer's limits) up to 900 mm high for landscaping purposes. Some types of blocks are able to be laid in convex or concave curves.

4.2.2 Since manual placing of the segmental blocks is expected, these blocks are commonly designed to weigh between 10 and 50 kg.

4.2.3 The blocks are laid in courses that can be secured in place by one or more of:

- interlocking courses
- concrete lips – the thickness of the concrete lip determines the stepping back of each course or the batter of the wall (Figure 3)
- a shear pin system (fibreglass or hot-dip galvanised steel pins) – the batter of the finished wall is determined by the pin hole positions (Figure 4).

4.2.4 Additional stability can be further derived by having hollows that are filled with selected fill as the work proceeds.

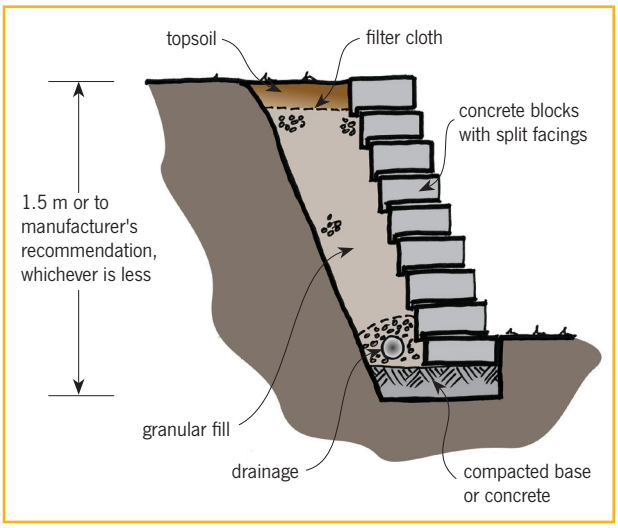

Figure 3. Gravity retaining wall in proprietary concrete.

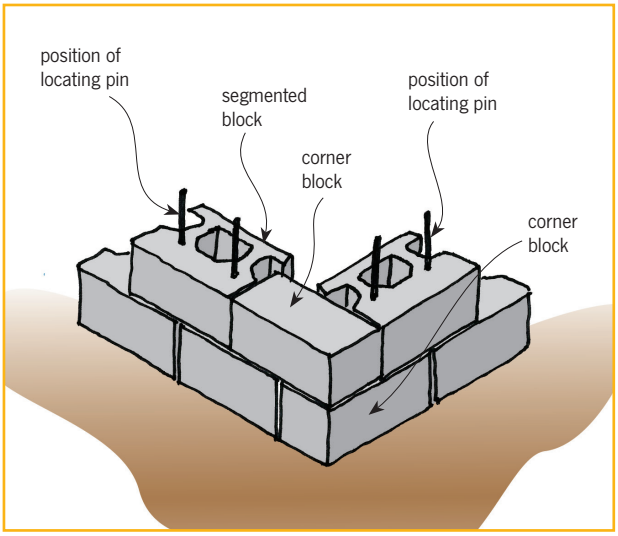

Figure 4. Gravity wall shear pins.

4.3 MSE RETAINING WALL

4.3.1 By fastening geogrid reinforcement at designated levels to segmental blocks and placing selected compacted fills between the geogrid reinforced layers, an MSE retaining wall (Figure 5) is formed with enhanced ductility.

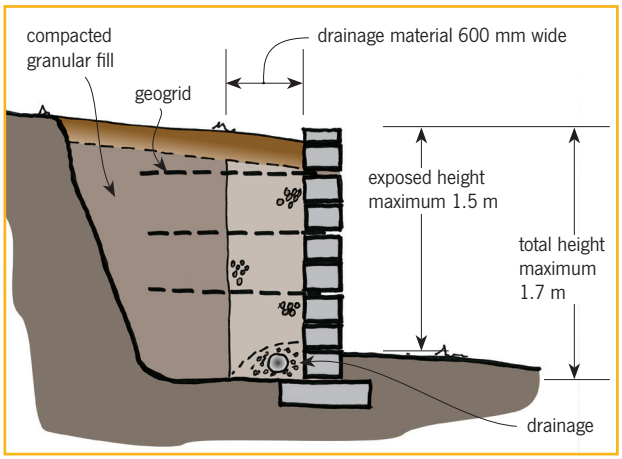

Figure 5. Reinforced segmental wall section (MSE wall).

4.4 CRIB WALL

4.4.1 Crib walls are a type of gravity wall. As low walls, they can be used for retaining and landscaping. A system of headers and stretcher units are mechanically keyed together at a batter of 1:4 and retain a granular type fill that provides the necessary weight for resistance to overturning.

4.4.2 Manufacturers' recommendations must always be followed for each situation. The allowable height of the retaining wall will vary with:

- the type of ground to be retained
- the ground configuration – the slope of ground below and above the wall
- the type of backfill used
- site drainage
- the effectiveness of drainage behind or within the wall to prevent water build-up
- the bearing capacity of the soil supporting the wall
- the overturning resistance of the wall, which is controlled by the header length.

4.4.3 Crib walls are usually built on a concrete foundation, but the manufacturer may allow compacted fill to be substituted for some types of low wall. On firm, accurately trimmed ground, low-rise walls can be constructed on a foundation of sleepers.

4.4.4 The length of a crib wall is determined by the module dimension of the stretchers, which should not be cut to fit a length.

4.4.5 By placing organic soil in the outer part of the wall, it can be planted with creeping or trailing plants.

4.4.6 Crib walls can be constructed from stretchers and headers made from concrete or H5-treated timber, which has the advantage of being lightweight.

4.4.7 Timber headers range from approximately 500 mm to 1400 mm in length, and stretchers range from 800 mm to 2200 mm (Figures 6 and 7).

4.4.8 Concrete headers typically range from 600 mm to 1500 mm in length, and front/back stretchers typically range from 1070 mm to 1500 mm (Figure 8). Front and back closers up to 2250 mm long alternate with the stretchers as the wall is constructed.

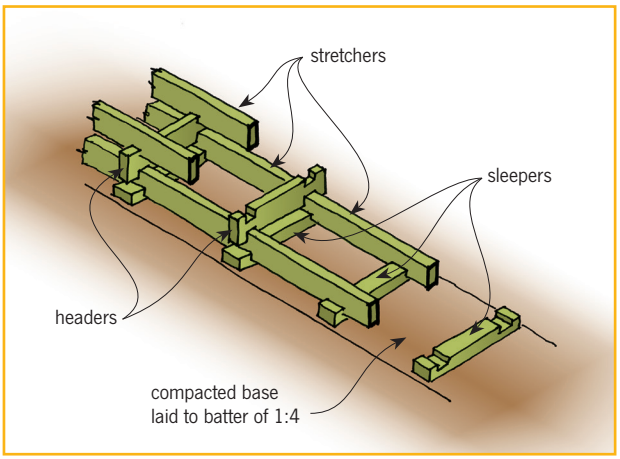

Figure 6. Proprietary timber crib walling. Total height to manufacturer's requirements.

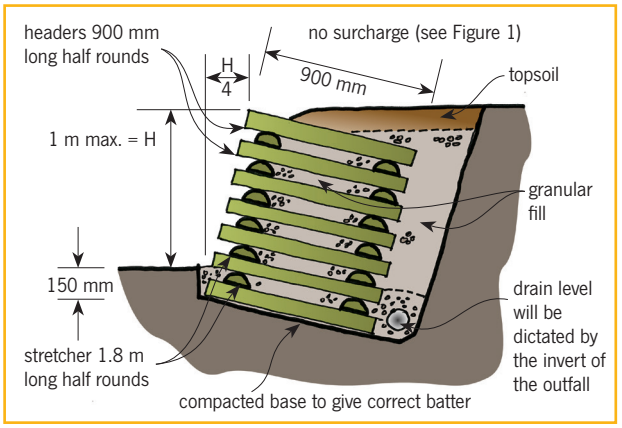

Figure 7. Retaining wall maximum 1 m high constructed in H5-treated half round timber.

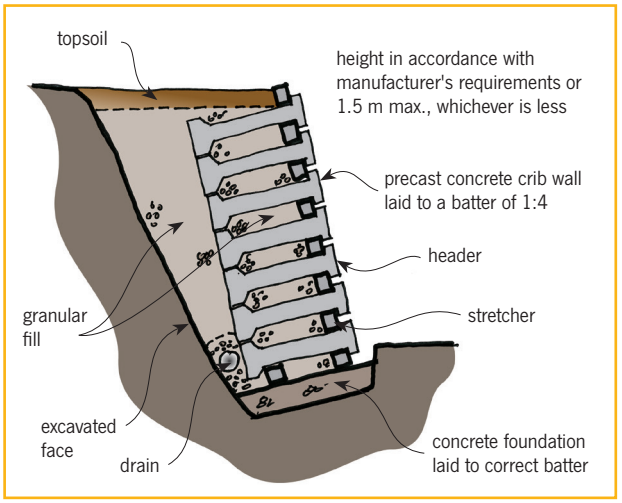

Figure 8. Proprietary concrete crib walling.

4.4.9 Crib walls are backfilled with clean free-draining crushed quarried rock or river gravel (with a maximum particle size of 100 mm and no more than 10% by weight of the material able to pass through a 150 micrometre sieve) after every third or fourth row of stretchers has been laid.

4.4.10 For all crib wall construction, obtain the specific unit dimensions and installation instructions from the system supplier.

4.5 CANTILEVER WALL

4.5.1 Cantilever walls rely on a combination of the tensile and compressive strength of the construction material and are stabilised by either a wide footing at the base of the wall or, in the case of timber walls, by a vertical member such as a pole or pile securely embedded into the ground.

4.5.2 Concrete cantilever walls may be constructed from reinforced in situ concrete formed in shuttering or from reinforced precast concrete masonry units. Remember that the finish of in situ concrete will only be as good as the shuttering or formwork and that shuttering must be well braced to prevent spreading. Designs for concrete or concrete masonry cantilevered walls are given in NZS 4229:2013 *Concrete masonry buildings not requiring specific engineering design* and BRANZ *Good Practice Guide: Concrete Slabs and Basements.*

4.5.3 Figure 9 shows the details of a concrete block wall suitable for non-cohesive granular soils, and Figure 10 shows a wall suitable for clay soils. Both walls are suitable for use in earthquake zone 3. In all cases:

- the minimum cover requirements for the steel reinforcing of 75 mm to ground must be achieved
- a minimum 25 MPa strength concrete must be used as given in NZS 4229:2013
- reinforcement must be grade 500E HD12 bars at 600 mm centres vertically and horizontally
- the wall must not be subject to compaction forces from machinery, such as a bulldozer running up behind the wall
- the supporting ground must meet the good ground requirements of NZS 3604:2011 *Timber-framed buildings* or NZS 4229:2013.

4.5.4 Timber cantilever retaining walls are constructed using:

- vertical posts or poles that are embedded in the ground and project above it to support horizontal rails (Figure 11)
- driven timber posts or poles.

4.5.5 The vertical members are radiata pine poles or square piles treated to hazard class H5, typically at spacings between 900 mm and 1200 mm, and usually set into concrete or tightly packed crushed stone. Rails can be half rounds or 50 mm radiata pine planks, treated to hazard class H4 as a minimum (using H5-treated timber will enhance the durability of the wall), which may be tongued and grooved to

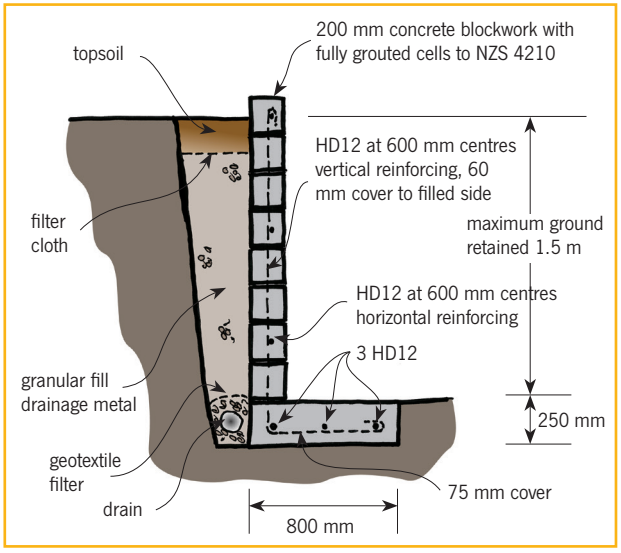

Figure 9. Concrete masonry retaining wall for non-cohesive granular soil.

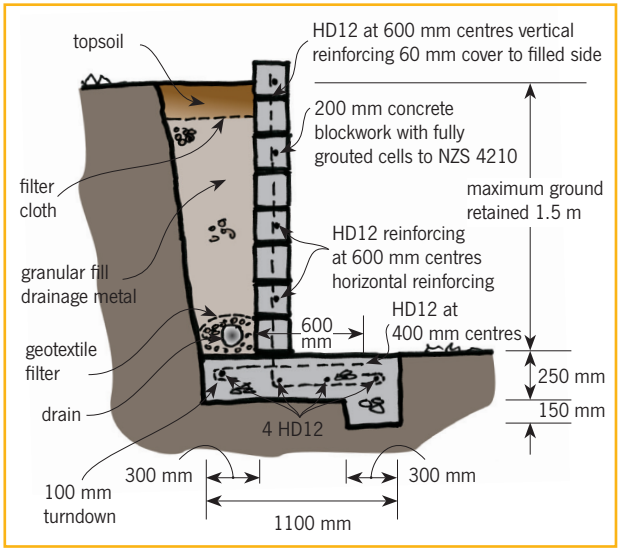

Figure 10. Concrete masonry retaining wall for clay soil conditions.

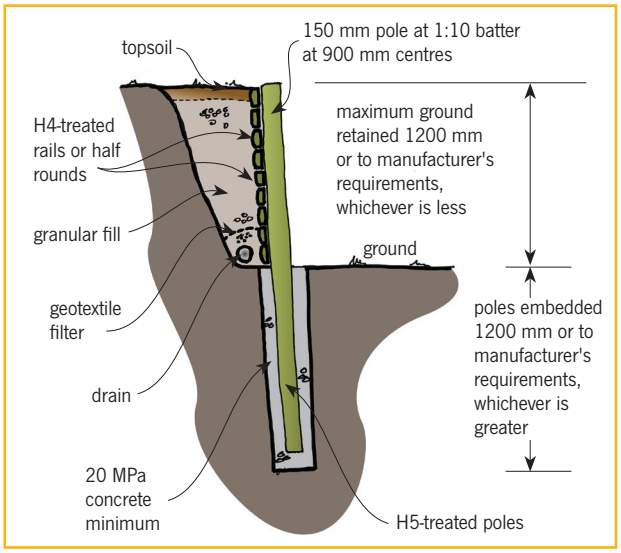

Figure 11. Cantilevered pole retaining wall – 1200 mm maximum height or to manufacturer's requirements, whichever is less.

allow them to interlock. Details of the construction and depth of pole embedment (typically a minimum of 1200 mm is required) vary with the type of soil. Recommendations should be obtained from the system supplier.

4.6 GABION WALLS

4.6.1 Gabion walls are a gravity retaining wall system that consists of steel mesh or wire baskets filled with rocks or stone that are stacked to form a retaining wall:

- Baskets can be supplied in a range of sizes to suit different wall configurations.
- Baskets can be formed to suit specific shape requirements.
- Locally sourced fill materials may be used provided they are sufficiently hard and durable.
- The wall may provide some inherent flexibility to accommodate movement.

4.6.2 Typical installation requirements include:

- not exceeding a 2:1 height-to-width ratio unless specifically designed
- inclining walls to improve stability – typically 7°
- locating a geotextile fabric between the gabion and adjacent soil

Low gabion wall.

- specifying a level of corrosion protection to the steel cage that is suitable for the environment and soil types
- obtaining and following the supplier's assembly instructions for the baskets, which are likely to be supplied as a flat pack
- a recommended fill size of 75–250 mm, depending on basket mesh opening sizes
- securing the bottom baskets to the ground as detailed by the supplier – typically steel rods are used
- filling baskets carefully in layers using weather-resistant non-friable insoluble and sufficiently hard angular to round rock to give durability – angular rock is considered to provide less face deformation as the rocks tend to interlock within the cage
- following the supplier's instructions when filling to ensure the wire coating is not damaged, cells are evenly filled and the face rock is hand placed to give a consistent neat and compact appearance
- allowing for settlement by slightly overfilling the basket and securely tying lids on completion of filling
- lacing or connecting the individual baskets in accordance with the supplier's instructions
- ensuring the bottom of the wall is 150–200 mm below the finished ground level to laterally locate the wall – low walls on good ground may be able to be laid on compacted base course (some manufacturers allow walls up to 1 m high to be laid on 100 mm of base course (removing the top 100 mm of topsoil is required) over good ground
- for multi-unit walls, ensuring upper units are tied to the completed lower unit before filling.

5.0 DRAINAGE

5.0.1 To limit the possible build-up of water pressure behind the wall, it is essential to provide suitable drainage behind all types of walls:

- Drainage should consist of a 300 mm minimum vertical layer of clean metal or gravel immediately behind and to within 150–200 mm of the top of the wall.
- Installing a layer of filter cloth under the topsoil is recommended to prevent the soil restricting the drainage within the granular fill.
- A slotted drainpipe or drainage coil must be installed behind the foot of a solid wall, where possible, to collect the water and dispose of it to an approved stormwater drainage system via a silt trap – installing a drain is also recommended for more open wall systems such as crib walls. A slotted drainpipe should be protected by a filter cloth to prevent it from silting up.
- Weepholes should be provided at the foot of any solid wall. Open walls such as crib walls and gabions will allow the drainage of some groundwater.

6.0 FURTHER READING

Ministry of Business, Innovation and Employment (MBIE)
New Zealand Building Code compliance documents:
- B1 *Structure* Acceptable Solution B1/AS1
- B2 *Durability* Acceptable Solution B2/AS1 (incorporating Amendment 7)
- F4 *Safety from falling* Acceptable Solution F4/AS1

Codewords 32 (October, 2008)

Standards New Zealand
NZS 3602:2003 *Timber and wood-based products for use in building*
NZS 3604:2011 *Timber-framed buildings*
NZS 3640:2003 *Chemical preservation of round and sawn timber*
NZS 4210:2001 *Masonry construction: Materials and workmanship*
NZS 4229:2013 *Concrete masonry buildings not requiring specific engineering design*

BRANZ publications
Good Practice Guide: Concrete Slabs and Basements 2nd edition 2012

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ISSN 1170-8395