BUILDING PERFORMANCE

Updates and clarifications to the residential guidance

If you’re using our Residential guidance (Repairing and rebuilding houses affected by the Canterbury earthquakes), you need to also use these updates and clarifications.

Published on 18 June 2018

Of interest to Insurers, Building consent authorities, Builders, Designers, Engineers

Index to the technical Q&As

Use this index to find what you need in the technical questions and answers, updates and clarifications to the Residential Guidance (Repairing and rebuilding houses affected by the Canterbury earthquakes). Once you’ve opened the index, use the Ctrl+F keyboard shortcut to find keywords.

Index to the technical Q&As

[PDF 235 KB]

(https://www.building.govt.nz/assets/Uploads/building-code-compliance/canterbury-rebuild/QA-index-sheet-issues1-to-10-inclusive.pdf)

Issue 10 - June 2018

Update 10 clarifies how the Residential Guidance can be applied to poorer quality concrete perimeter foundation walls that are sometimes referred to as 'rubble' foundations.

63. How does the Residential Guidance apply to 'rubble' concrete foundation walls?

The Canterbury rebuild has shown that houses in Canterbury have a wide variety of perimeter foundation walls. These range from reinforced concrete perimeter foundations that are compliant with the standard for building timber-framed buildings (NZS 3604), through concrete walls with nominal reinforcement, to unreinforced walls with large elements of loosely cemented stone or rock.

Section 1.4.3 Technical Scope of the Residential Guidance states, "The document focuses principally on one- and two-storey timber framed dwellings (ie houses built to NZS 3604 or its predecessor Standard)." This does not mean that every component or element of the house has to comply with current NZS 3604 requirements for the guidance to apply. Rather, it is intended that the scope of buildings covered by the guidance is similar to the scope of those covered by NZS 3604, ie one- and two-storey timber-framed dwellings.

It is worth noting that NZSS 95, a predecessor Standard to NZS 3604, stated that the brick, stone and concrete foundation walls shall have adequate bearing area to safely support the imposed loads. The reference to brick and stone means that masonry could be used as long as it supported the vertical loads, which was the principal function of earlier foundation construction.

The guidance does not contain specific repair solutions for 'rubble' foundations, and is not mandatory for developing a repair solution. However, information in the guidance will be useful for developing repair solutions to reinstate the original function of a damaged foundation. The repair work must meet the performance requirements of the Building Code, which have remained the same since the Canterbury earthquakes. Some of the methods in the guidance to repair cracks and repair or replace perimeter concrete foundations are applicable across the range of existing foundations, (whether they be considered as "rubble foundations", or they comply with NZS 3604) provided that careful consideration is given to the nature and condition of the foundation.

Applying the damage assessment methods and repair solutions provided in the guidance requires a good understanding of the overall performance of affected houses. In addition, the development of any repair solution requires case-specific consideration and professional engineering advice. Regardless of whether the Residential Guidance is used to develop a repair solution, all repair work must comply with the Building Code.

Issue 9 - May 2015

Update 9 provides clarification and further information on technical issues relating to the residential guidance (Repairing and rebuilding houses affected by the Canterbury earthquakes). These issues result from new information or feedback received on the guidance since its publication in December 2012.

59. Can poly-propylene precast panel shims be used for packing the tops of piles instead of slips of H5 timber?

(Guidance document reference - Part A, section 4)

The use of purpose made poly-propylene precast panel shims as a substitute for an H5 timber packer is acceptable for both Type A and Type B foundations. The poly-propylene shims are colour coded based on thickness. The maximum packing height using precast panel shims for this residential application is 50mm. The minimum number of shims should be used and where more than two shims are used they are to be pinned together at two locations, these being the diagonally opposite corners of the stack of packers.

60. If a house is being relevelled what is the relevelling objective?

(Guidance document reference - Part A, section 2.3)

Extract from Part A section 2.3 page 2.4 (columns 2 and 3 referenced are from to Table 2.3).
"If the floor profile fits within the criteria in column 3, the expectation is that the relevelling processes will result in a floor that is as near as reasonably practical to level and certainly within the criteria stated in column 2 These are the maximums of desired slope and differential displacement, and tighter tolerances should be targeted during relevelling processes.

The indicator criterion of 50mm in Table 2.3 is provided solely as an indicator for initiating a re-level. Finished floor levels are expected to be as close to level as can practically be achieved and re-levellers have indicated that, given the control they have on the lifting process, they will be able to achieve far better than 50mm out of level in most circumstances.

61. What is the required sealant for multi-unit building inter-tenancy walls detailed in Part E (Figures 23.30 and 23.32) of the Residential Guidance?

(Guidance document reference - Part E, section 26.3)

Sealant is only shown generically in Figures 23.30 and 23.32 (partially reproduced below in Figure 1) to detail the junction of a non-rated (fire and/or acoustic) ceiling or wall to a retained firewall. The new ceiling or side walls in the Figures are not fire or acoustic-rated. Therefore the sealant does not need to be either fire- or acoustic-rated and any flexible sealant can be used.

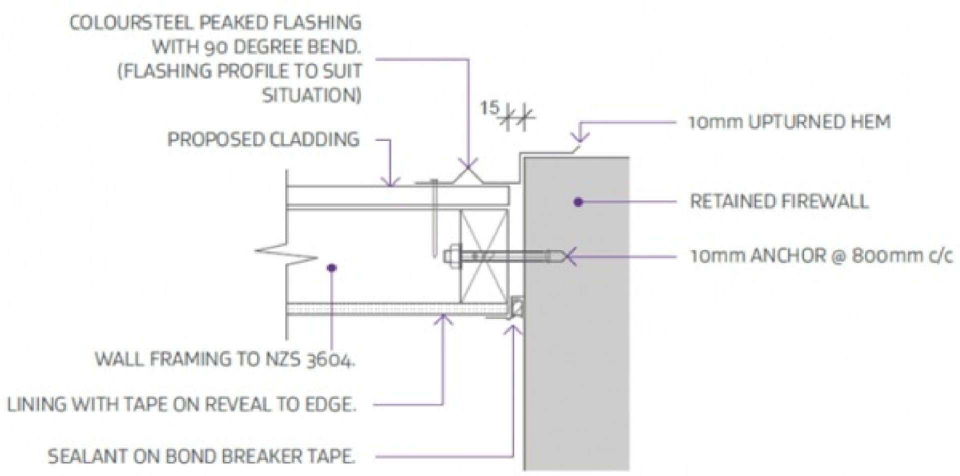


Figure 1: Extract from Figure 23.32 from Part E of the Guidance

Sealant is not shown on other details in Part E, but inter-tenancy walls are noted as being "installed to meet minimum FRR of 30/30/30 and minimum STC of 55". If sealants form a component of a proposed new or rebuilt inter-tenancy wall then the specified sealant must meet both fire and acoustic performance requirements. Where a proprietary inter-tenancy wall system is specified, the sealant that is part of that system must be used.

62. Where a brick veneer cladding is being reinstated are there ways of combining the requirement for cavity drainage and sub-floor ventilation when there are no vents in the perimeter foundation?

(Guidance document reference - Part A, Appendix A)

Often, older brick veneers on Type B foundations had ventilation vents and/or open perpends in the lower courses to allow the cavity behind the veneer to ventilate. The vents also provided a way for air to circulate through the subfloor space if there were no vents in the perimeter foundation because there was no barrier between the two spaces. If the veneer is to be re-built on such a perimeter foundation, it is important that at least the same veneer ventilation configuration and capacity as previously provided is incorporated into the new work to ensure that the previous level of cavity and subfloor ventilation is retained.

If it is unknown or uncertain what the previous veneer ventilation configuration was, and/or you are unable to replicate it, then current building code compliance requirements must be adopted for the new veneer. That compliance can be achieved by either complying with E2/AS1 or by providing an alternative solution complying with Clause E2. Expert advice has indicated that while not allowed under E2/AS1 for new construction, it is acceptable for this reinstatement work to continue with an airway between the cavity and the subfloor space but a link to the roof space is to be avoided.

Dealing with the building wrap

The existing or new building wrap is brought down to the lowest point on the framing without covering the airflow path to the subfloor space. At the top, the wall wrap is turned out over the top of the veneer (or where possible behind) the soffit or in a similar way to close off the roof space from the cavity while still retaining the required ventilation at the top of the veneer. If the top of wall wrap cannot be done with one piece of wrap, an additional section of wrap may need to be lapped to the wall wrap to achieve the seal.

Veneer cavity ventilation and drainage

The veneer cavity ventilation requirements can be achieved by including appropriately sized vents (to E2/AS1, section 9.2.6) in the lower courses of the new veneer and at the top of the veneer. Drainage is provided by leaving the mortar out of vertical perpends of the lowest course (also to E2/AS1) and creating a mortar fillet behind the veneer to force the moisture to flow to the outside.

Subfloor ventilation

Subfloor ventilation requirements are different to cavity ventilation requirements and are calculated in accordance with NZS3604 6.14.1. It is unlikely that the slots for cavity ventilation will be sufficient to also provide ventilation to the subfloor space and additional ventilation grills are required in the lower brick course to achieve the necessary amount of ventilation area.

To illustrate the above, Figures 1 and 2, respectively show cases of bearer at right angles to the perimeter foundation and parallel to the perimeter foundation, and Figure 3 shows options for the top of the veneer cavity.

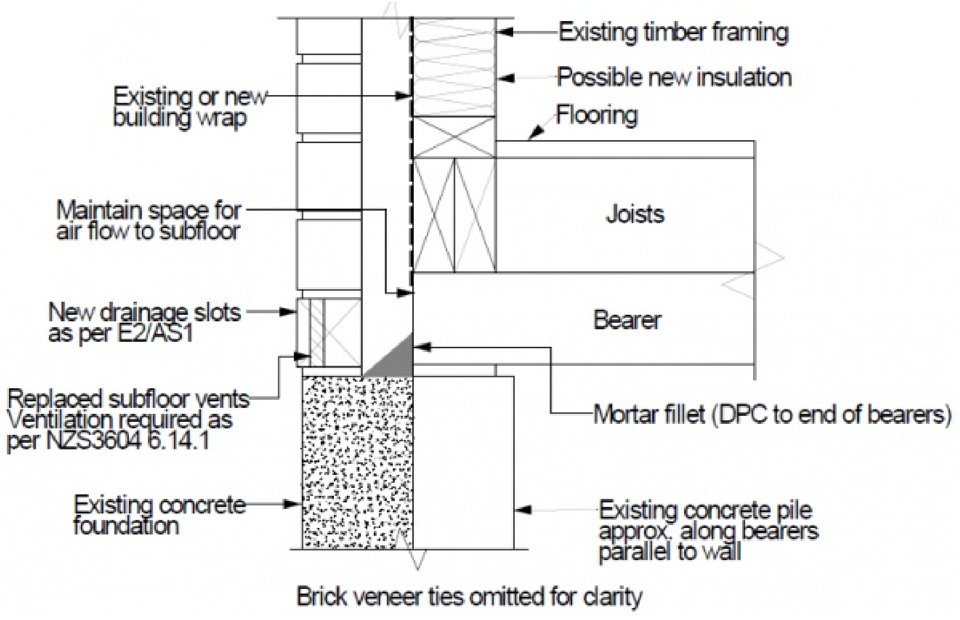


Figure 1: Ventilation and drainage requirements when bearers at right angles to the wall when no ventilation is provided in the perimeter foundation.

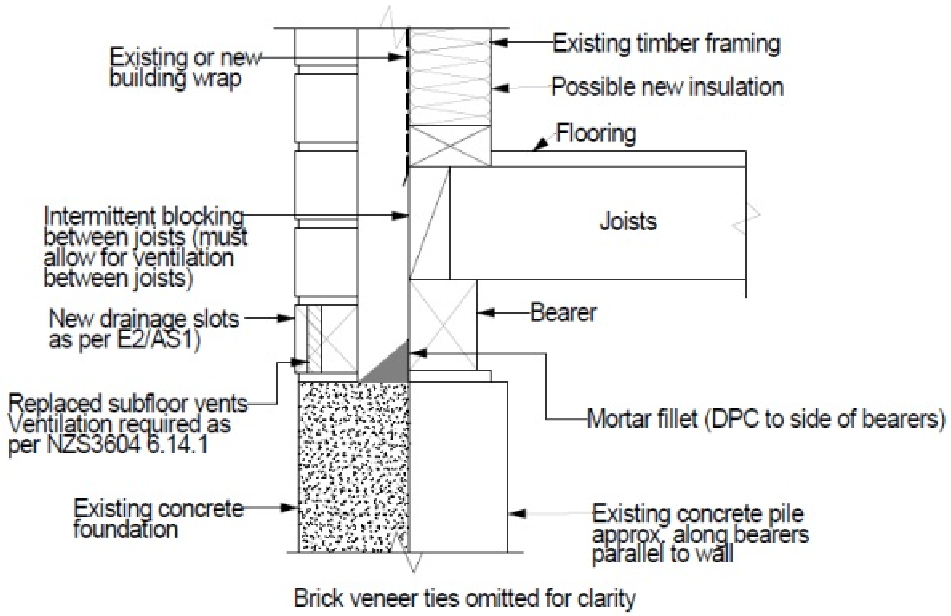


Figure 2: Ventilation and drainage requirements when bearers parallel to the wall when no ventilation is provided in the perimeter foundation.

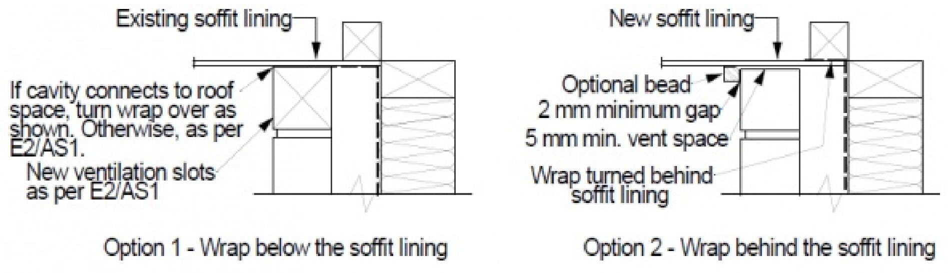


Figure 3: Options for finishing the top of the veneer cavity

Repairing and rebuilding houses affected by the Canterbury earthquakes (https://www.building.govt.nz/building-code-compliance/canterbury-rebuild/repairing-and-rebuilding-houses-affected-by-the-canterbury-earthquakes/)

Issue 8 - February 2015

Update 8 provides clarification and further information on technical issues relating to the residential guidance (Repairing and rebuilding houses affected by the Canterbury earthquakes). These issues result from new information or feedback received on the guidance since its publication in December 2012.

BRANZ Test Report SC1221/1, Capillary test on tailings with liquefaction sand filling the voids, (https://www.building.govt.nz/assets/Uploads/building-code-compliance/canterbury-rebuild/repairing-and-rebuilding-houses/branz-test-report-capillary-test-on-tailings-with-liquefaction-sand-filling-the-voids.pdf) Report to MBIE, 1 December 2014

Report to the Residential Engineering Advisory Group: Condition of polythene DPM under cracks in concrete floor slabs (https://www.building.govt.nz/assets/Uploads/building-code-compliance/canterbury-rebuild/repairing-and-rebuilding-houses/report-to-rag-condition-of-polythene-under-cracks-in-concrete-floor-slabs.pdf)

54. What is the requirement for embedment depth for the underslab of a Type 2A-150, 2A-300 and 2B surface structure foundations? For example can we embed it 100mm, and have 50mm or 200mm above ground depending on the underslab depth?

(Guidance document reference - Part C, section 15.4.4 and Q&As 45 & 46)

The underslab for Type 2A foundations shown in Figures 15.18 and 15.19 has been buried for aesthetic reasons and so that gardens could be planted adjacent to the house.

If it is preferred to raise the level of the underslab for either 2A or 2B surface structure foundations so that the underslab is only embedded 100mm into the ground and have it partially above ground, it would be advisable to use only one layer of DPM in order to improve the friction resistance to lateral sliding between slab and ground. The sub-base needs to be well prepared. Care should also be taken against the possibility of localised undermining of the slab.

55. Are the DELETION references in the margins in the Residential Guidance referring to text that has been removed?

For the avoidance of doubt; DELETION in the margin means that a deletion has occurred from the previous version and what you see in the text still applies, i.e. the text next to the deletion note remains part of the current guidance.

56. The partial replacement of slabs or the raising of slabs by injection through the slab can damage the polythene Damp Proof Membrane (DPM) under the slab. What is required to reinstate the vapour barrier to ensure appropriate moisture control?

(Guidance document reference - Part A, Appendix A 4)

The impact of gaps in or damage to the DPM is cumulative. Occasional spot gaps in the vapour barrier, whether at laps or from individual holes dispersed across the floor that are no more than half the slab thickness in diameter, are not likely to significantly impair barrier performance. However where there is a line of damage then repair is required.

Check that the DPM remains an effective vapour barrier

It is important to remember that the function of the DPM is to provide resistance to vapour movement. The DPM has never been intended to be a tanking material. Consequently, this answer only applies to situations where water pressure cannot build up on the underside of the membrane (i.e. the water table is lower than the membrane). This answer requires that at least one of the following conditions are met:

- The water table is at least 500mm below the DPM ; or
- There is well graded and compacted granular material under the slab, or,
- Where rounded, poorly graded river run material (tailings) has been used as sub-base, fine sand particles have not filled the voids (as a result of liquefaction) and formed a migration path for ground moisture to the underside of the DPM.

Satisfying any of these conditions will ensure that capillary rise is controlled (refer Reference 1 below).

Ideally water table information could be obtained from long term monitoring of an appropriate standpipe. It is rare however for this information to be available for a specific site. Therefore, it is recommended that the designer compare the ground level elevation for the site in question with the 85 percentile groundwater table information held on the Canterbury Geotechnical Database. This will provide guidance on whether the groundwater level is within 500mm of the vapour barrier (refer Reference 2 below).

Records of liquefaction observations will assist in determining the level of investigation required to establish the second condition. If liquefaction was present then testing adjacent to the slab is recommended.

If there is a reasonable likelihood that the water table may be within 500mm of the vapour barrier and that liquefaction material is present, then an intrusive investigation through the slab is likely to be required to establish that the tailings are still clean. A hole of approximately 300mm square or diameter in the slab should be sufficient for this purpose.

Where the water table is less than 500mm below the level of the DPM under the slab and fine sand particles have filled the voids in the tailings, specific advice should be obtained regarding suitable repair strategies for the particular site conditions.

Injection points

For holes drilled in the slab for relevelling the slab by injection, the reinstatement requirements are different depending on the diameter and spacing of the holes used.

Where holes are up to 50mm in diameter and spaced more than 1.2m apart, the drilled holes will comprise typically less than 0.1% of the surface area of the DPM and, for the reasons noted above, are not likely to significantly impair barrier performance. While cement grout is less likely to provide a (plug) repair to the DPM at these holes, it is expected that the likelihood of vapour leakage through the holes is negligible.

Where a closed cell resin product is used to lift a slab, the resin can be expected to provide an adequate repair to the DPM once the injection is complete.

For holes larger than 50mm in diameter, the holes in the DPM must be repaired regardless of the spacing. There are specialist concrete additive products available on the market that will provide sufficient resistance to water vapour to effect an adequate repair to the DPM.

DPM evaluation beneath slab cracks

Field investigations to date have indicated that the DPM is typically undamaged beneath slab cracks up to 30mm wide (refer Reference 3 below).

When cracks are greater than 30mm, it should be possible to visually inspect the DPM for damage. If there is evidence of moisture which gives rise to concern about DPM failure beneath slab cracks up to 30mm wide, or beyond slab crack locations, there are moisture detection devices that can be used to carry out non-invasive and non-destructive investigations. Note that Table A4.1 of the MBIE Residential Guidance suggests slab break-out and partial replacement for cracks greater than 20mm.

Also refer generally to Appendix A4 of the Residential Guidance.

Partial Slab replacement

At the junctions of replacement slab sections the new piece of polythene DPM must overlap the existing by a minimum of 150mm and be taped in accordance with 7.5.6.1 of NZS3604. Care must be taken during the cutting out process to avoid damage to the DPM beneath a slab. The following process is suggested for taping the new DPM to an undamaged in-place DPM.

- Mark out the junction on the slab between the part to be retained and the part to be replaced.
- Cut out and remove the slab 200mm inside the replacement line.
- Check slab depth and reinforcement location and cut along junction line at a depth of 10-20mm less than measured slab depth making sure all reinforcing is cut.
- Excavate granular base or tailings from under cut section to remove support. Drop DPM out of the way.
- Inspect exposed base/tailings and ground, and removed base/tailings for evidence of high water table and/or liquefaction material. If the two conditions stated above are satisfied, then proceed; if not, seek specific advice.
- Manually and carefully break out slab section, cutting into smaller sections as required, and fold back DPM for access to granular base. This will require careful cutting of the existing DPM diagonally, almost into the corners of the broken out section.
- Provide granular base to 7.5.3 of NZS3604 and prepare surface suitable for polythene DPM to 7.5.6.2 of NZS3604.
- Lay new DPM and fold down existing DPM. Trim edges to be tidy and straight, suitable for taping, and ensure lap remains a minimum of 150mm. Tape lap to 7.5.6 of NZS3604.
- Pour new concrete section to 7.5.8 of NZS3604. reinforcing steel is required in the new slab concrete and must be adequately tied to the retained slab on both sides.

At internal corners of slab cut-outs it may be difficult to achieve no damage to the retained DPM or complete laps between new and retained DPM. For the reasons noted above, small holes in the retained DPM or small gaps in the new lap are not likely to be of any consequence.

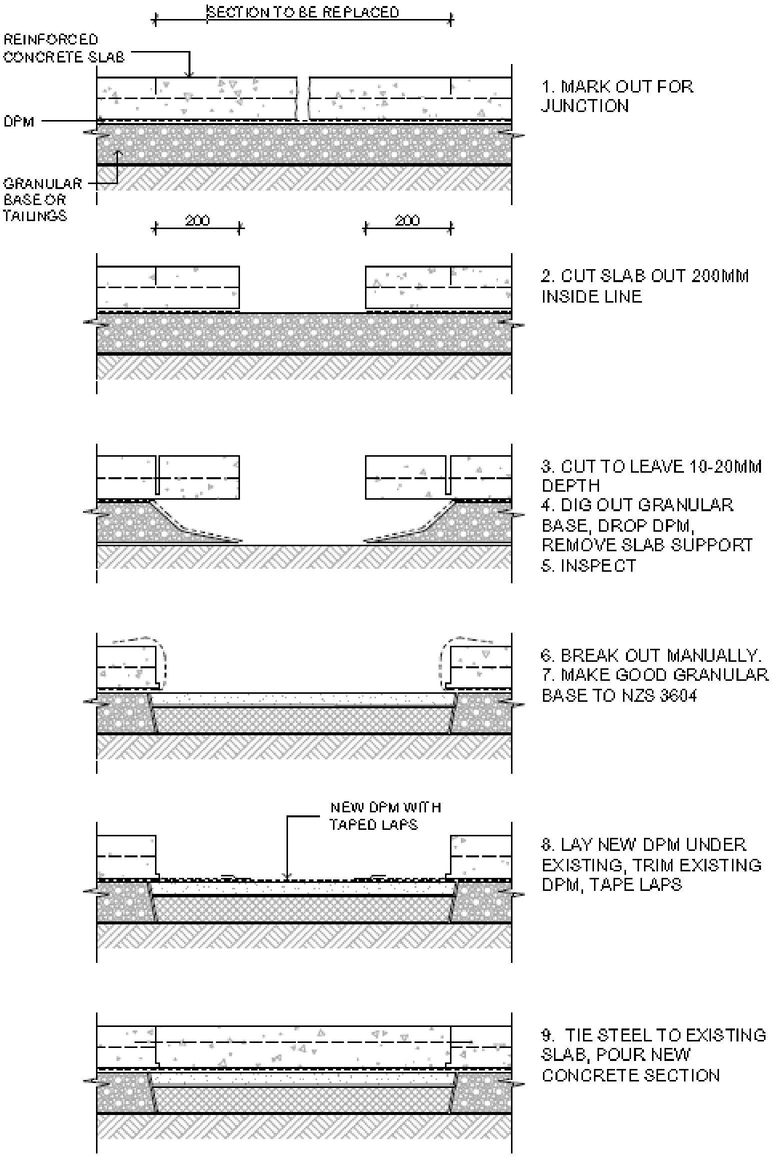


Figure 1: Steps in the partial removal and replacement of a slab with DPM reinstatement guidance.

References

BRANZ Test Report SC1221/1, Capillary test on tailings with liquefaction sand filling the voids, Report to the Ministry of Business Innovation and Employment, 1 December 2014.

van Ballegooy, S.; Cox, S. C.; Thurlow, C.; Rutter, H. K.; Reynolds, T.; Harrington, G.; Fraser, J.; Smith, T. (2014) Median water table elevation in Christchurch and surrounding area after the 4 September 2010 Darfield Earthquake: Version 2, GNS Science Report 2014/18, April 2014. ISBN 978-1-927278-41-3. 79 p and 8 Appendices.

G J Beattie, Report to the Residential Engineering Advisory Group 'Condition of polythene DPM under cracks in concrete floor slabs', 8 August 2012).

57. What are the skill requirements for people taking measurements of levels and wall verticality as part of the information gathering toward determining a repair strategy?

(Guidance document reference- Part A, Section 2.3)

Due to the widespread uses to which levelling data may be put, and the many techniques available, no one specific measurement method can be recommended. In cases of doubt about the status of the floor levels, only a competent person or someone operating under the direction of a competent person should make decisions on measurement methods and equipment.

Residential new building level and verticality is often set out by the builder who is familiar with the building standard tolerances and equipment needed to achieve the required result. Where the results of the survey do not clearly indicate to the engineer how the building has performed during the earthquake sequence and that a more accurate survey may help in the assessment, the engineer should consider engaging a survey specialists such as a Registered Professional Surveyor (RPSurvs) or Licensed Cadastral Surveyor (LCSs). For more information the following reference is relevant:

References

Report from the NZIS Working Party – Review of Survey Practices in Relation to the Canterbury Rebuild June 2014.

58. What was the outcome of the review of the guidance on Type 2 foundation plywood skirts referred to in Q&A 44?

(Guidance document reference - Part C, Section 15.4.4)

Figure 15.21, Detail of plywood stiffening to Type 2 surface structures, has been superseded. In Q&A 44 the need for the plywood skirts for Type 2A foundations was stated to be under review. In the Part E guidance on MUBs, page 22.2, the requirement for perimeter skirts was removed for Type 2A and Type 2B foundations under MUBs. This guidance now applies to all residential use of the Type 2 foundations provided they are within the height limits set in Table 20.4.

Repairing and rebuilding houses affected by the Canterbury earthquakes (https://www.building.govt.nz/building-code-compliance/canterbury-rebuild/repairing-and-rebuilding-houses-affected-by-the-canterbury-earthquakes/)

Issue 7 - October 2014

Update 7 provides clarification and further information on technical issues relating to the residential guidance (Repairing and rebuilding houses affected by the Canterbury earthquakes). These issues result from new information or feedback received on the guidance since its publication in December 2012.

50. Now that the new report UCD/GCM-14/01 “CPT and SPT Based Liquefaction Triggering Procedures” by R Boulanger and I Idriss (2014) has been published (and is available at CPT and SPT Based Liquefaction (http://cgm.engr.ucdavis.edu/library/reports/) Triggering procedures), can this liquefaction analysis methodology be substituted for the Idriss & Boulanger (2008) method cited in the MBIE guidelines?

Yes, the Boulanger & Idriss (2014) deterministic methodology can be optionally substituted for the Idriss & Boulanger (2008) methodology when using the MBIE guidelines for sites in the Canterbury earthquake region, provided the following requirements are met:

- At SLS for sites in the Canterbury earthquake region, both the M7.5 / 0.13g and a M6 / 0.19g design case must be analysed (and the highest calculated total volumetric strain from either scenario adopted).
- At ULS it will be sufficient to simply analyse the M7.5 / 0.35g case for sites in the Canterbury earthquake region.
- If fines contents are being derived from CPT data, the new FC / Ic relationship in the 2014 methodology is to be adopted. A CFC fitting parameter of 0.0 should be used, unless appropriate lab data or other evidence supports a different value. For example, Robinson et al (2013) suggests a value of CFC = -0.07 could be adopted for liquefiable soils along the Avon River.

For sites outside of the Canterbury earthquake region, it would only be appropriate to adopt the 2014 methodology where a seismic hazard deaggradation plot or other data has been examined to determine appropriate representative design events.

While for consenting purposes this updated methodology is currently optional, it is recommended that engineering practices begin phasing in this method (where it is applicable) as soon as is practicable. It is not intended that previously written geotechnical reports are necessarily revisited. Once the 2014 methodology has been adopted by an engineering practice, it is not appropriate to switch back to the 2008 methodology for subsequent projects.

Background

The 2014 method is an update to the 2008 method, incorporating additional liquefaction case history data (much of it derived from the Canterbury Earthquake sequence) and a re-fitting of the analysis methodology to that updated data set. 50 Christchurch case histories have been added to the database and Christchurch now accounts for 20% of all data points. The main changes are:

- A new formulation for magnitude scaling factor (MSF).
- Details of the formulation for the equivalent clean sand adjustment for fines content (for CPT data, but not for SPT data).
- Details of the formulation for the derivation of cyclic resistance ratio (for CPT data, but not for SPT data).
- A revised relationship between Ic and fines content.

Of these updates to the overall methodology, all but the first one (MSF) presents little difficulty in the adoption of the 2014 analysis method. However the new formulation of the magnitude scaling factor is a significant departure from the methods commonly used to date. The new MSF formulation now not only relates to earthquake magnitude but also varies with the density of the soil (ie qc1Ncs or (N1)60cs – refer to Figure 2.6 below, taken from UCD/GCM-14/01 "CPT and SPT Based Liquefaction Triggering Procedures" by R Boulanger and I Idriss (2014)).

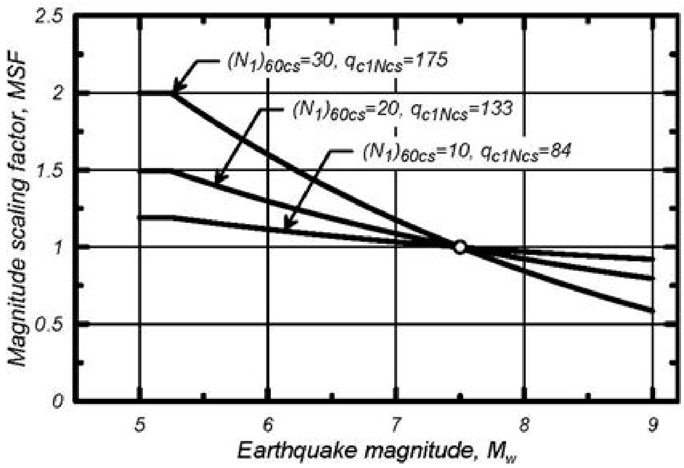


Figure 2.6. Variation in the MSF relationship with q_{c1Ncs} and with $(N_1)_{60cs}$ for cohesionless soils

At M7.5 the MSF is still equal to 1.0 for all soils, using the new formulation. However convenient this might at first appear (given that the New Zealand SLS and ULS design accelerations for liquefaction are derived for equivalent M7.5 events), for actual events that differ from M7.5, the new MSF can vary significantly depending on the density of the soil. For an M6 event for example, for which the 2008 MSF would be about 1.5, the 2014 MSF will vary from 1.6 for a soil with a qc1Ncs of about 175, to 1.1 for a soil with a qc1Ncs of about 80.

Using the 2008 analysis method, a design event of M7.5 and 0.13g will give similar analysis outcomes (in terms of liquefaction triggering and calculated volumetric strain) as design events of M6 and 0.19g, or M8 and 0.11g. Using the 2014 formulation however, quite different outcomes can occur depending on the density of the soil. Using the example in the preceding paragraph, a soil which previously was calculated to have a factor of safety (FOS) of 1.0 against liquefaction triggering could now in fact have a FOS that varies from 0.75 to 1.1 for an M6 event, depending on the density of the soil. Given that volumetric strain occurs up to a FOS of 1.5, the difference in calculated settlement can be significant.

This means that if the 2014 method is adopted, continuing to use the 'universal' M7.5 design events at SLS and ULS is no longer necessarily appropriate, given the higher probability of occurrence of an event in the order of M6 in the Canterbury earthquake region. The implications of this in the 2014 methodology are particularly evident for the SLS event, for typical Christchurch conditions. At ULS levels of shaking, the differences are quite muted and therefore it is not considered necessary to carry out a separate M6 calculation at that level of shaking.

In theory, a large number of magnitude/pga combinations could be assessed for any particular site, as a large number of fault rupture scenarios are possible, and are present in the probabilistic seismic hazard model that is used to derive the design event. This is not a practical approach however. Instead, it is considered appropriate to analyse the most likely SLS design scenario magnitude (as well as the M7.5 standard design event). Based on a deaggradation of the seismic hazard for Christchurch and comparisons of settlement estimates obtained using both the 2008 and the 2014 methods, a nominal event of 0.19g at M6 has been determined as a 'representative' SLS design event. For other geographical locations the representative event will be different, and in some locations more than one event might be appropriate, depending on the local seismicity.

References

- Boulanger, R. W., and Idriss, I. M. (2014). "CPT and SPT based liquefaction triggering procedures." Report No. UCD/CGM-14/01, Center for Geotechnical Modeling, Department of Civil and Environmental Engineering, University of California, Davis, CA, 134 pp.
- Idriss, I. M., and Boulanger, R. W. (2008). Soil liquefaction during earthquakes. Monograph MNO-12, Earthquake Engineering Research Institute, Oakland, CA, 261 pp.
- Robinson, K., Cubrinovski, M., and Bradley, B.A. (2013). "Comparison of actual and predicted measurements of liquefaction-induced lateral displacements from the 2010 Darfield and 2011 Christchurch Earthquakes." Proc. 2013 Conference of the New Zealand Society for Earthquake Engineering (NZSEE 2013), Wellington, New Zealand, 26-28 April.

51. The updated Boulanger & Idriss (2014) method includes a probabilistic approach to liquefaction analysis. Can this probabilistic approach be utilised where the MBIE guidelines are being used?

The standard deterministic liquefaction assessment method in both Idriss and Boulanger (2008) and in the updated Boulanger & Idriss (2014) methods (as well as other methodologies from other authors), incorporate a threshold probability of liquefaction P_L of 15%. The use of that threshold probability should be continued when using either method for assessing liquefaction under the MBIE guidelines. However, on 'well tested' sites where settlement calculations do not correlate well with observed damage or actual settlements, and a decision is being considered to favour site observations over calculated settlements, an examination of calculated settlements at a higher threshold P_L (for example $P_L = 0.5$) may give further guidance to the engineer in making that judgement.

52. Is it acceptable to build up the top surface of an existing Type B perimeter foundation to create a horizontal surface on which to build a new veneer that is correctly aligned with the window sills and soffit?

(Guidance document reference – Part A, sections 2.2 and 2.3)

Yes it is acceptable to build up the perimeter foundation of a Type B house to provide a level surface on which to build a new veneer as long as the foundation is still in good condition and does not need to be replaced (refer Table 2.2 or Table 2.3 of the MBIE guidance for re-level/rebuild indication criteria). This will allow the aligning of the veneer with the window sills and the soffits after relevelling the floor using jack and pack methods.

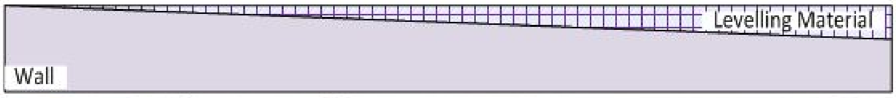
In order to build up the foundation, the existing veneer will need to be removed and replaced. While the veneer is removed the home owner may choose to install insulation in the wall framing but this is optional for the homeowner and is not a regulatory requirement.

To create a horizontal surface for an existing Type B perimeter foundation, use the following procedure.

Step	Action
1	**Remove the brick veneer.**
2	**Undertake any crack repairs on the existing foundation (see Appendix A4 for crack repair guidelines).**
3	**Clean and roughen the top surface of the foundation.** **Note: This ensures that there is a good bond between the old and the new work.**
4	**Use timber formwork (eg plywood with foam grout seal to existing wall face) to contain the levelling material.**

5 **To create the new level top surface for the veneer use either epoxy grout, mortar or cement grout, depending on thickness of filler required.**

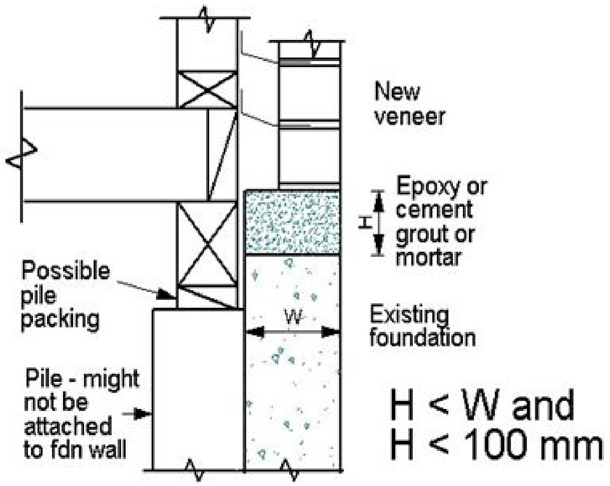
Recommended re-levelling materials and thicknesses					
Epoxy modified grout		Cement mortar to NZS4210:2001		Cement grout to NZS 4210:2001	
Min 1 mm	Max H = W	Min 5 mm	Max 20 mm	Min 20 mm	Max is Lesser of H = W or H= 100mm



6 **Roughen the top surface of the grout to ensure a good bond with the veneer bedding mortar course.**

7 **Replace cladding with a modern 70 series veneer which has a significant reduction in weight over the old veneer.**
Note: Other lighter cladding materials may also be used provided that they are appropriately installed to ensure that all relevant clauses of the Building Code are satisfied.

8 **Fix the new veneer to the framing according to the requirements of Table 18A of Building Code clause E2/AS1.**
Note: The ties provide all of the required lateral load resistance for the veneer and the perimeter foundation only provides gravity support for the veneer.

9	**Limit the ratio of the filler height over the foundation beam width to one, or 100 mm, whichever is the lesser amount.** **Note**: If heights are greater than 100mm then specifically designed mechanical fixings should be used.  **Figure 1: Section elevation; width to height ratio of wall extension**
10	**If the veneer is positioned back from the outside edge of the wall, a chamfer may be created at the junction between the veneer and the foundation beam.**
11	**Coat the outside face of the foundation with plaster to provide a clean finish.**

53. When designing a Type 1 foundation, the MBIE Guidance document indicates a pile foundation depth of 350mm. Is there a maximum depth, or criteria, for the footing depth?

(Guidance document reference – Part C, Figure 15.16 and Table 15.6)

Yes there is a specific footing depth of 350mm below ground level as shown on Figure 15.16 in the MBIE guidance. The thickness of concrete below the pile should be 100mm.

The reason for this is that shallow piles such as these around the perimeter of the foundation, braced by the plywood cladding, are capable of displacing the soil should the ground spread beneath the building as shown on Figure 15.16. This specific footing depth is required on all piles of the Type 1 foundation. The Type 1 foundation is able to be used on sites where the lateral spread is expected to be less than 200mm in a ULS event and there is no expectation of significant lateral spread in an SLS event (see Table 15.6). Unbraced piles in the Type 1 foundation are expected to lean over up to 100mm in a ULS earthquake and may require replacement after the event.

Repairing and rebuilding houses affected by the Canterbury earthquakes (https://www.building.govt.nz/building-code-compliance/canterbury-rebuild/repairing-and-rebuilding-houses-affected-by-the-canterbury-earthquakes/)

Issue 6 - July 2014

Update 6 provides clarification and further information on technical issues relating to the residential guidance (Repairing and rebuilding houses affected by the Canterbury earthquakes). These issues result from new information or feedback received on the guidance since its publication in December 2012.

47. In section 13 of the guidelines it states that the scope of a deep geotechnical

investigation in TC3 must be determined by the geotechnical professional responsible for giving advice on the property in question, and that person must be either a CPEng geotechnical engineer or a PEngGeol with competence, suitable relevant training and experience in foundation investigations and liquefaction assessment. Do the same requirements apply for professionals who are carrying out investigations for foundation repairs on TC3 sites, where only a shallow investigation is being carried out?

(Guidance document reference – Part C, section 13)

It is preferable to have a specialist geotechnical professional involved in foundation work on TC3 sites. However, where remediation only involves simple repairs or relevelling, for which the MBIE guidelines do not require a deep investigation or liquefaction assessment, a shallow investigation can be carried out under the oversight of a CPEng engineer. The CPEng engineer must have relevant experience in ground investigation and the interpretation of the results of such investigations, and also enough relevant experience to be able to recognise on a site if further investigation, or a different approach is warranted.

The CPEng engineer must be familiar with the requirements of section 3.4.1 of the guidelines (which covers shallow investigations), and in particular the need to take investigations as deep as is practicable.

48. Recent public articles in ASCE Civil Engineering and NZ Geomechanics News, as well as data coming out of the EQC ground improvement trials, provide new information regarding the scope and limitations of LMG. How does this affect the guidelines?

(Guidance document reference – Part C, section 15.3)

The EQC trials showed that where LMG is injected as a **ground improvement** method at shallow depths with little control (which can result in heave and dilation of the ground), then little or no improvement results, and in fact there may be a slight increase in the liquefaction vulnerability of the ground. However where it is injected for **lifting** purposes (refer Appendix A1.9 of the guidelines), then for typical house foundation loads, lifts up to about 75 - 100mm are possible without adversely affecting the ground.

MBIE recommends that, in the absence of additional specialist input and analysis, lifting of houses with LMG should be limited to about 100mm. Greater lifts are possible where there is additional confinement from a heavy building, or the lifting is carried out at depths of greater than 4m. It is important to consider the integrity of the surface crust under such circumstances. This should be carried out only by a specialist contractor with appropriate experience, skills and technical expertise.

The EQC field trials found that LMG as a ground improvement technique was often not effective at shallow depths. As a result of these trials LMG has now been removed as a ground improvement option from section 15.3 of the guidelines (ie the methodology 'Low mobility grout columns (Type 5)' specified on page 15.30 of section 15.3 of the guidelines is no longer part of the MBIE guidelines). There has only been very limited use, if any, of LMG as a ground improvement method for houses to date.

References:
Wharmby N (2014): "Relevelling Residential Properties Using Low Mobility Grout (LMG)" NZ Geomechanics News (Issue 87), 26 – 29.
Wilcox K (2014): "Team Tests New Zealand Soil Improvements" ASCE Civil Engineering online article id 23622330636.

49. What area of subfloor ventilation opening is required where a type 2A or 2B foundation has been constructed with a double polythene slip-layer?

(Guidance document reference – Part C, section 15.4)

If the under-slab is buried and overlaid with backfill (eg as shown in Figures 15.19 and 15.20 of the Guidance) then the NZS3604 Clause 6.14.1 ventilation requirements of 3500mm^2 per m^2 of floor area apply.

Where the under-slab is 50mm or more above ground level (eg as shown in Figure 23.33 of the Guidance), then the amount of ventilation can be reduced. This reduction is only applicable where the slab top does not get inundated with water or where a pond cannot be formed. To ensure compliance the top of the slab is required to be a minimum of 50mm above ground level.

The Types 2A-300 and 2B foundations can make use of the double DPM layer to resist vapour transfer similar to having a vapour barrier on bare ground beneath the house. Therefore the ventilation requirement is 700mm^2/m^2 of floor area (see clause 6.14.3 of NZS 3604).

However, the 2A-300 and 2B foundation designs have a 300mm deep edge to the perimeter where moisture can find its way into the slab and then the subfloor space. This moisture path is taken into account on the basis that this edge area would need ventilation at 3500mm^2/m^2, and this ventilation is added to that required for the slab plan area.

A range of Type 2A-300 and 2B floor plans has been investigated to determine the vapour contribution from beneath the slab and the sides of the slab. It was determined that the provision of 1100mm^2/m^2 was sufficient to ventilate the space on these floors.

Repairing and rebuilding houses affected by the Canterbury earthquakes (https://www.building.govt.nz/building-code-compliance/canterbury-rebuild/repairing-and-rebuilding-houses-affected-by-the-canterbury-earthquakes/)

Issue 5 - April 2014

Update 5 provides clarification and further information on technical issues relating to the residential guidance (Repairing and rebuilding houses affected by the Canterbury earthquakes). These issues result from new information or feedback received on the guidance since its publication in December 2012.

42. Schedule 1 of the Building Act 2004 was amended, effective 28 November 2013. Does the revised wording in Schedule 1 alter the advice provided in Appendix A3 on assessment and repair options for chimneys regarding the need for a Building Consent?

(Guidance document reference – Part A, Appendix A3)

Section A3.3 currently states:

The Ministry's document Canterbury Earthquake Recovery Information for Home Owners and Building Practitioners – Building Work that does not require a Building Consent as at 20 September 2010 notes that repairing or replacing a chimney or flue does not require a building consent. [Note: This Ministry document has now been updated, refer to 19 March 2014 'Building Work that does not require a Building Consent' (https://www.building.govt.nz/projects-and-consents/planning-a-successful-build/scope-and-design/check-if-you-need-consents/building-consent-exemptions-for-low-risk-work/schedule-1-guidance/).

Chimney damage was widespread in Canterbury during the earthquake sequence. Demolition of the chimney does not require a building consent (pursuant to Schedule 1, Clause 31), provided that the building is not more than 3 storeys high and the removal does not affect:

- the primary structure of the building; or
- any specified system; or
- any fire separation.

Repair or reconstruction of the chimney may require a Building Consent depending on the degree of damage and the repair envisaged. You will need a building consent if the repair or replacement involves the "complete or substantial replacement of any component or assembly contributing to the building's structural behaviour or fire-safety properties" as per Schedule 1 Clause 1(3)(b).

Schedule 1 Clause 1 provides an exemption for the repair or maintenance of any component or assembly incorporated in or associated with a building, provided that comparable materials are used. If the chimney has retained structural integrity and there is only minor repair work, then the general exemption for repair, maintenance, and replacement in Schedule 1(1) could apply.

The Clause 1 exemption could also apply where there has been damage to the upper part of the chimney's height that is replaced with a metal flue system and light-weight surround as per the second heading of Section A3.7.2 of the Guidance. In this case it is considered that the assembly is comparable as it performs the same function and does not reduce compliance with the Building Code (ref. Building Act Section 42A(2)(b)), and it is not a complete or substantial replacement.

Note: The Clause 1 exemption will not apply if new or recycled bricks are to be used because of the heavy weight of the chimney, now acting as a single block, and the uncertainty about how the connection into the lower unreinforced part of the chimney may affect the structural performance of the building (per Schedule 1 (3)(b)). The Guidance does not recommend this approach and such a proposal would need to be considered on a case-by-case basis. A building consent will be required unless the Territorial Authority agrees to grant an exemption under Schedule 1 Clause 2, which provides the Territorial Authority the discretion to issue exemptions where "the completed building work is likely to comply with the building code; or if the completed building work does not comply with the building code it is unlikely to endanger people or any building".

Substantial replacement of the chimney will also require a building consent unless the Territorial Authority agrees to grant an exemption under Schedule 1 Clause 2.

Christchurch City Council, for example, has a list of work they will consider under Clause 2, refer to Form B-391. This includes the removal and replacement of brick chimneys, irrespective of whether structure and cladding are comparable. For more information, please see the Christchurch City Council website (https://www.ccc.govt.nz)

43. Is it acceptable to notch bearers and piles beneath an existing Type A or Type B dwelling to assist with the relevelling process?

(Guidance document reference – Part A section 4.3, Part A appendix A1, Part C section 14.2)

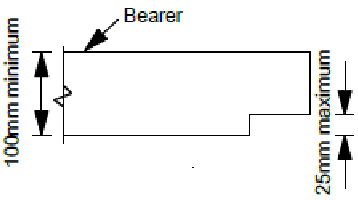
Yes it is acceptable to notch these elements, provided that they are notched within the limits detailed in this answer. It must be done as part of the floor relevelling where some jacking and packing is undertaken and the final resulting floor is overall no lower than it was prior to the relevelling process commencing. This ensures that Building Act section 112 is complied with in relation to Building Code Clause E1.

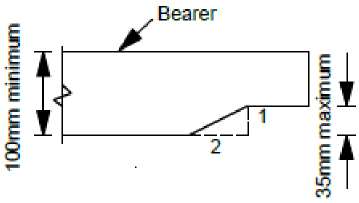
In a timber floor system the bearers support the joists and are in turn supported by the piles and/or perimeter foundation walls. If we consider each case separately, there are:

- ends of bearers
- mid-span supports of bearers
- ends of joists
- mid-span supports of joists.

Case 1: Ends of bearers

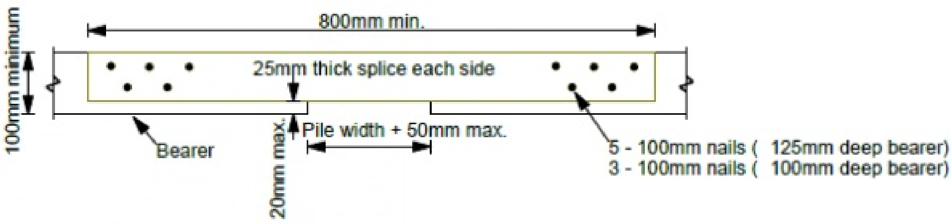
The ends of 100mm and 125mm deep bearers may be notched by 20mm with a square cut transition. If the transition is sloped at 2 to 1 then the notch depth may be increased to 35mm. The remaining capacity of the bearer is adequate to take normal design floor loadings of 1.5kPa. On some occasions, engineers have chosen to use a steel shoe adjacent to the notch for added strength.





Case 2: Intermediate supports of bearer

Where bearers span over intermediate supports, they may be notched on the underside (compression) face of the bearer by 20mm over a maximum length equivalent to the pile width plus 50mm. 800mm long by 25mm thick side splice plates must be added, fixed at each end (5 - 100mm nails for 125mm deep bearer and 3 – 100mm nails for 100mm deep bearer). In this case, removal of some of the bearer depth will reduce the bending strength and stiffness. It is therefore necessary to add splice members to the sides of the bearer to recover the original bending strength at the notch. It is important that the splice elements also bear on the top of the pile for the splice to be effective.

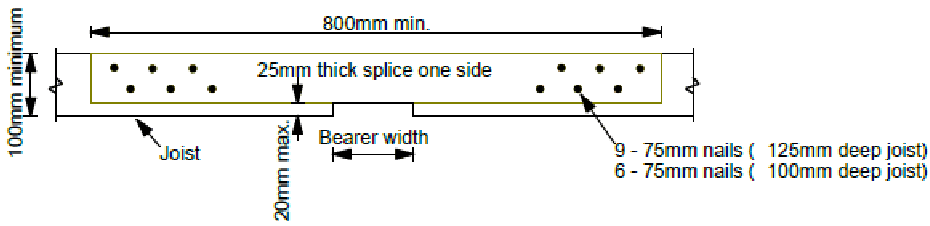


Case 3: Ends of Joists

The ends of 100mm and 125mm deep joists may be notched by up to 20mm with a square cut transition. If the transition is sloped at 2 to 1 then the notch depth may be increased to 30mm. It is not necessary to add a metal shoe to the joists. Notching the ends of joists is similar to the ends of bearers except that the loads at the notch are less. Most joists in Type B floors are 125mm deep but there will be instances where they are 100mm deep. The above limits may be applied to joists deeper than 125 mm. Specific designs may allow deeper notches in these sizes.

Case 4: Intermediate support of joists

At intermediate supports, 100mm and 125mm deep joists may be notched up to 20mm with a square cut transition. An 800mm long by 25mm thick side splice is required to be fixed to each joist at the notched crossing (9 – 75mm nails each end for 125mm deep joist and 6 – 75mm nails each end for 100mm deep joist). In this case, removal of some of the joist depth will reduce the bending strength and stiffness. It is therefore necessary to add splice members to the sides of the joist to recover the original negative bending strength at the notch. It is important that the splice elements also bear on the top of the bearer for the splice to be effective.



44. For the TC3 Type 2A-300 and 2B (refer to Q&A 38 and Q&A 46) surface structure foundations, because the piles are cantilevering from the concrete slab, is it necessary to have the plywood skirt around the perimeter of the foundation?

(Guidance document reference – Part C section 15.4.3)

The plywood skirt was originally specified when the Type 2A-300 and 2B surface structure foundation designs were developed by MBIE because of a concern that there may be some “shrinkage slop” of the piles in the slab. The overall structural strength of the system would not be affected by this but there may have been some small rotation of the pile at service loads. Observations of completed Type 2B foundations have shown that the piles are well anchored in the slab and therefore there is no need for the plywood skirt. The need for a plywood skirt on Type 2A-150 foundations will be reviewed based on further field observations.

The designer must still design and document requirements to address aesthetic and architectural details and code compliance issues such as weathertightness, subfloor ventilation, and durability.

45. For TC3 Type 2A and 2B surface structure foundations, are there alternative ways of finishing the perimeter of the slab and perimeter subfloor cladding?

(Guidance document reference – Part C, Section 15)

Consideration has been given to providing another detail that has the edge of the slab in the same vertical plane as the cladding line above, and enables the slab to be cast at a level slightly above the surrounding ground level.

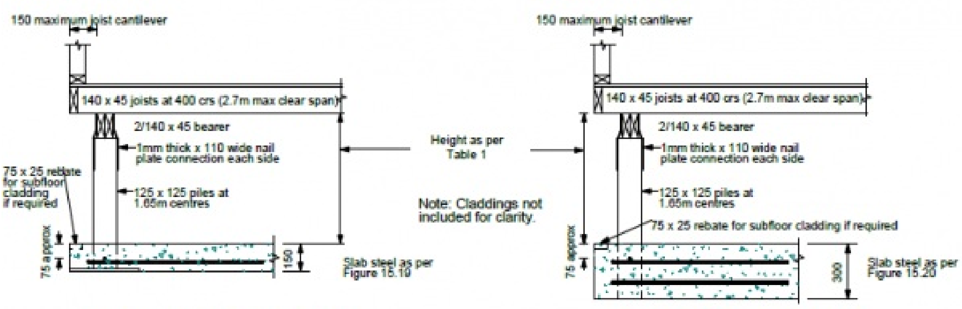
The TC3 Type 2A and 2B foundation options were developed on the principle that the timber piles cantilevered from the slab, thus providing the lateral support for the superstructure under wind and earthquake loading. All piles are expected to introduce a bending action to the slab under lateral loading.

Figures 15.19 to 15.21 of the Guidance indicate that the slab should extend 500mm beyond the exterior row of piles. If the joists and bearers are cantilevered beyond the bearer or the last pile in the row respectively, then it is possible to cover most of the extension. However, it has been determined that a reduction in the joist size to 140 x 45mm and a change in the bearer size to 2/140 x 45mm members is a more economic option for these structures. This means that the span (a maximum 2.7m clear span when at 400mm centres) is less than a 190 x 45mm joist can span and extra rows of piles will be required. It also means that the overhang of the joist on the bearer (the cantilever) may only be 150mm. This is suitable for both single and two storey houses with light roofs and either light or medium weight wall cladding.

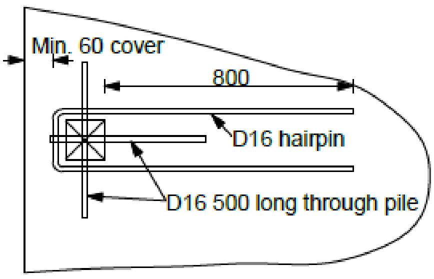
Water should not be allowed to pond beneath the floor of the completed dwelling. Therefore, the ground level under the house (Type 2A) and the top surface of the slab (Type 2B) should be set at a level that is higher (approximately 50mm) than the surrounding land.

The new details for the Type 2A and Type 2B under-slab in TC3 have been developed as shown in the following figures. These details should be read in conjunction with Figures 15.19 to 15.21 of the Guidance.

(See also Q&A # 44 on the deletion of the plywood skirt on TC3 Type 2 foundations)



Cross section - Type 2A Cross section - Type 2B



Plan

Table 1: Maximum distance between top of slab and underside of joist (m)

	(150mm slab)	(300mm slab)
Single storey light weight wall/light roof	1.00	1.15
Single storey medium weight wall/light roof	1.00	1.00
Two storey light weight wall/light roof	0.75	0.75
Two storey medium weight wall/light roof	0.60	0.60

46. There have been some changes to the descriptions of the TC3 Type 2 surface structure foundations in the Guidance. Can you please provide a summary of the available Types and their specifications?

(Guidance document reference – Part C section 15.3)

The Guidance provides details for a Type 2A and a Type 2B surface structure foundation. The Type 2A has a 150mm concrete under-slab and the Type 2B has a 300mm under-slab. Both had a 600mm reinforced gravel layer included beneath the slab. Q&A # 38 extended the guidance for Type 2A to allow, as an alternative, a 300mm slab to be used in the better areas of TC3 (where the SLS settlements were <100mm) without the need for a 600mm reinforced gravel layer.

For greater clarity, the Type 2 surface structure systems have been re-named as follows:

Identifier	Description	Maximum calculated SLS settlement (mm)
(refer to Figure 1)	A 150mm concrete under-slab in combination with a 600mm reinforced gravel layer (refer to Figure 15.19)	100mm
(refer to Figure 2)	A 300mm concrete under-slab, reinforced as per type 2b slab over a 150mm layer of compacted well graded sandy gravels extending 500mm beyond the edge of the slab and with a geotextile layer under the compacted gravel. The geotextile layer is to be turned up at the ends of the gravel layer and returned a minimum of 1m under the slab.	100mm
(refer to Figure 3)	A 300mm concrete under-slab in combination with a 600mm reinforced gravel layer (refer to Figure 15.20)	200mm

Figure 1: TC3 Type 2A-150 Foundation

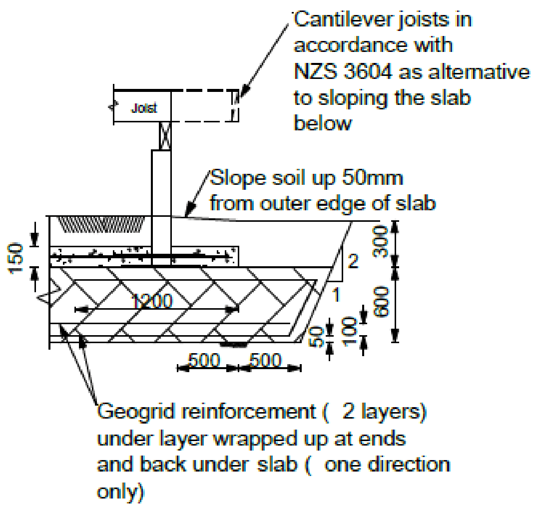


Figure 2: TC3 Type 2A-300 Foundation

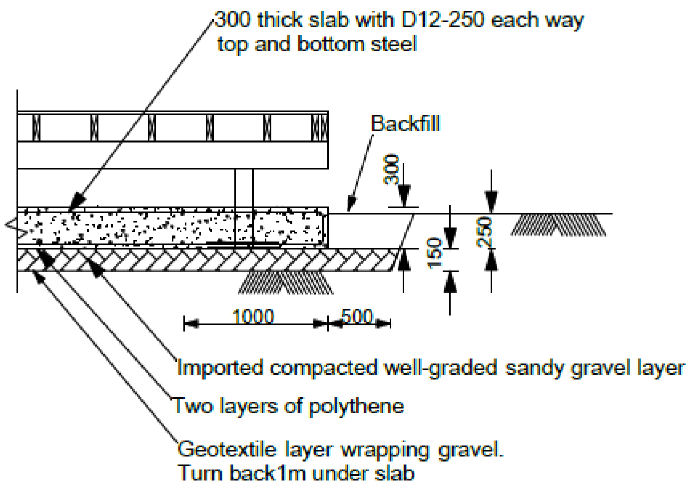
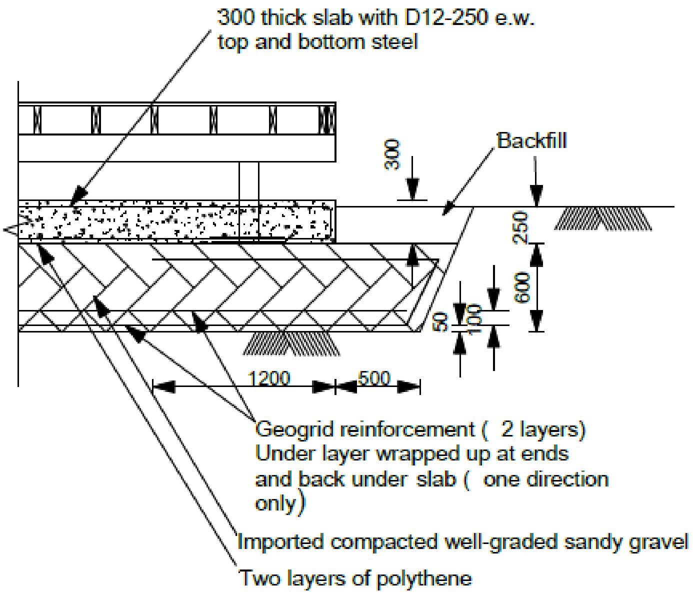


Figure 3: TC3 Type 2B Foundation



For multi-unit buildings (MUBs), a range of similar style foundation systems has been developed. The special conditions associated with MUBs have meant that the gravel layer has a different function from the raft beneath a detached house. Details are provided in Part E Table 20.1.

Repairing and rebuilding houses affected by the Canterbury earthquakes (https://www.building.govt.nz/building-code-compliance/canterbury-rebuild/repairing-and-rebuilding-houses-affected-by-the-canterbury-earthquakes/)

Issue 4 - December 2013

Update 4 provides clarification and further information on technical issues relating to the residential guidance (Repairing and rebuilding houses affected by the Canterbury earthquakes). These issues result from new information or feedback received on the guidance since its publication in December 2012.

39. I have a foundation in TC3 that satisfies the criteria in Table 2.3 for a relevel. Can I use the methods in Appendix A1 to relevel the foundation because the appendix title states that it only applies to TC1 and TC2, implying that it doesn't apply for TC3?

(Guidance document reference – Part C, section 14.2.2, section 4.3, and Appendix A1)

Because you are in TC3 the start point is Table 2.3 to determine whether a relevel is indicated. If this is possible then section 14 of the Guidance is relevant as this relates to TC3 repairs. Section 14.2.2 notes that for a Case 2 foundation relevel (and local repair) if less than 25-30% of the foundation beam does not require replacement then relevelling and repairs can proceed in accordance with Part A, section 4.3. Section 4.3.1 makes reference to the available relevelling methods in Appendix A1 (4th paragraph).

40. The process diagram for repairing foundation on TC3 sites in Part C, Figure 14.1 refers to section 5 in the bottom right blue box, is this correct?

(Guidance document reference - Part C, section 14, Figure 14.1)

The reference should be to section 15.

41. What guidance is available for design of new retaining walls for the Port Hills?

(Guidance document reference – Part A, section 6)

An MBIE working group is presently preparing detailed guidance for the design of new residential retaining walls for the Port Hills and these are expected to be released early in 2014. Limited guidance is available within the supporting documents of the Building Code (Acceptable Solutions or Verification Methods) for the design of earth retaining structures. The only specific provision for earthquake loading is provided in the wall foundation example given in Appendix C of B1/VM4. A load factor of 1.5 is specified in NZS 1170.0:2002 for earth pressure under gravity loading, which will provide a certain level of earthquake resistance for many cases.

The impending guidance provides more specific details on how to comply with Clause B1 of the Building Code when designing earth retaining structures and cut or fill batters for earthquake actions. These should be designed to resist earthquake effects in the following situations:

- where failure or excessive deformation of the batter or retaining structure might contribute to loss of life within or safe egress from a dwelling (ULS) or loss of amenity of a dwelling (SLS), or
- where the height of the batter or retaining structure is greater than 3m (including the height of batter above the retaining structure).

Recommendations will incorporate a procedure for determining design acceleration coefficients considering the importance of the structure and its tolerance for permanent earthquake induced deformations. The guidance will provide more detailed performance requirements for residential retaining walls with the most critical case being where a retaining wall is built integral with a dwelling or directly supports a dwelling. In such cases no movement can be tolerated at the SLS and only limited movement even at the ULS. Familiar quasi-static design procedures based on the Mononobe-Okabe equations will generally be appropriate with acceleration coefficients derived from the revised interim Z factor for Christchurch. For walls where more movement can be tolerated after earthquake shaking, acceleration reduction factors may be adopted from a Newmark sliding approach.

The document will also reference selected published research into the properties of loess soils of the Port Hills.

Repairing and rebuilding houses affected by the Canterbury earthquakes (https://www.building.govt.nz/building-code-compliance/canterbury-rebuild/repairing-and-rebuilding-houses-affected-by-the-canterbury-earthquakes/)

Issue 3 - November 2013

Update 3 provides clarification and further information on technical issues relating to the residential guidance (Repairing and rebuilding houses affected by the Canterbury earthquakes). These issues result from new information or feedback received on the guidance since its publication in December 2012.

37. Do the following statements in Part C, section 14.2.2 of the guidance mean that houses in major or severe lateral stretch areas cannot be repaired or relevelled?

"Repairs and relevelling can be considered if a site is assessed as having moderate (refer Table 12.1) lateral stretch potential" and also "If a site is assessed as having major or severe lateral stretch potential (ie, >200mm at ULS), then neither repairs nor relevelling should be undertaken without careful engineering analysis and consideration".

(Guidance document reference - Part C, section 14.2.2)

No. An engineer should take account of a number of factors in making this assessment and a five-step process is outlined in section 12.2.2 of the guidance. There are inherent uncertainties in predicting lateral spread.

However, if a site has been relatively well tested by the earthquake series, and if no lateral stretch damage or only minor lateral stretch damage has occurred to the house, then a repair or relevel may well be appropriate. In other cases, it might be appropriate to make some simple upgrades to the foundation system where this is feasible, to reduce the risk of damage from such future events. (An example would be to add external reinforcing to a concrete edge beam to enhance its ability to withstand stretch).

38. Where the guidelines indicate the need for a surface structure Type 2A, could a Type 2B detail be used instead, without the underlying gravel raft?

(Guidance document reference - Part C, section 15.4.4)

Yes it can, in a modified format. The 300mm reinforced concrete slab will need to be underlain with a minimum of 150mm compacted hard fill (well-graded sandy gravels) that is in turn underlain with geotextile. The 150mm compacted gravel layer will need to extend 1m outside the foundation line, with the geotextile wrapped over the 1m extension and returned a minimum of 1m under the concrete slab.

Repairing and rebuilding houses affected by the Canterbury earthquakes (https://www.building.govt.nz/building-code-compliance/canterbury-rebuild/repairing-and-rebuilding-houses-affected-by-the-canterbury-earthquakes/)

Issue 2 - September 2013

Update 2 provides clarification and further information on technical issues relating to the residential guidance (Repairing and rebuilding houses affected by the Canterbury earthquakes). These issues result from new information or feedback received on the guidance since its publication in December 2012.

20. How is the guidance document applicable to additions in TC3?

(Guidance document reference – Part C, sections 13.1 and 15.1) [link to section in document]

The Guidance document was written for rebuilds or repairs to existing houses, and not specifically for additions. The same principles can be applied to additions. However, where this will result in differing foundation types for the addition, the future performance of the house must be carefully considered. In some cases a carefully detailed seismic separation joint could be used to minimise the damage that will occur in a future event (and protect amenity by being readily repairable). In other cases this may not be possible, and the entire building will need to be upgraded to the same foundation system. Alternatively an application to the Building Consent Authority for a modification or waiver of the Building Act can be made. For the latter a sound justification is needed, and a consideration of the current risk for the existing house.

Any addition up to 3 square metres, with no more than 1.5m additional width added to the existing building, can be made without soils testing if a simple foundation and floor system (to match the existing) is used, and the new foundation section is well tied into the existing foundation. Larger additions or multiple additions require soils testing and specific engineering input, including an understanding of the existing foundation, how it has performed to date, and how it might perform in a future large earthquake.

21. Are there durability issues with grout injection (cement or urethane)?

(Guidance document reference - Part A, Appendix A1) [link to section in document]

MBIE understands that at least two companies are able to offer 50 year minimum durability warranties on grout injection products, both cementitious and urethane based.

22. Under the following circumstances: where the property is located in TC3, and there are static bearing issues (either soft ground, fill or peat problems), and a pile founding layer cannot be identified can a relevellable concrete surface structure (as per section 15.4.8) that is supported on deep piles designed for static conditions only be constructed?

(Guidance document reference – Part C, section 15.4.8)

Yes, as long as the site fits the criteria for a relevellable concrete surface structure – in other words SLS settlements over the upper 10m are less than 100mm. The purpose of this 'composite' design should be well signalled on design documents to avoid false future performance expectations.

23. If the geotechnical report for a TC3 site demonstrates that the site is suitable for TC2 foundations, will the official designation for the land be changed?

(Guidance document reference – Part A, section 3.1)

No. The official Technical Category designations, being an area-wide guide for appropriate levels of site investigation and assessment, will not change and will remain in place.

24. Can an Engineering Technology Practitioner (ETPract) substitute for the CPEng requirements in the guidance?

(Guidance document reference – Part A, section 3.4, and Part C, section 13.1, and various other references)

No.

25. When constructing a Type 2 surface structure on an extended Type 1 or 2 ground improvement option as per section 15.3.4 of the guidance, can the compacted gravel hardfill be omitted from the surface structure construction?

(Guidance document reference – Part C, section 15.3.4)

Yes, as long as geogrid reinforcing is still incorporated in the upper 600mm of the improved crust.

26.Could you clarify the design philosophy to be followed to determine the depth of ground improvement required for TC3 land?

(Guidance document reference – Part C, section 15.3.4)

In the first instance, refer to section 15.3.4. If using one of the standard MBIE deep ground improvement options included in the Guidance where depths of liquefiable soils exceed 10m, the treatments need to extend to where residual total settlements (not index values over the top 10m) from SLS do not exceed 50mm and ULS settlements do not exceed 100mm. It is recognised that in many cases this might be uneconomic, and in those cases the designers will need to revert to specifically engineered solutions.

27.Do the specific engineering design provisions to address lower than standard bearing capacities for TC1 and TC2 in section 3.4.1 also apply to TC3 sites?

(Guidance document reference – Part A, section 3.4.1)

Yes, where static bearing capacities do not meet specified index values, specific calculations can be carried out by an appropriately qualified geotechnical engineer to examine actual applied stresses compared to assessed bearing capacities.

28.Are TC3 Type 1, 2A and 2B surface structure foundation systems suitable for two-storey construction where lightweight roof and medium weight cladding is specified?

(Guidance document reference – Part C, section 15.1, Table 15.1, and section 15.4)

Yes (see also **Question 35** (https://www.building.govt.nz/building-code-compliance/canterbury-rebuild/updates-clarifications-residential-guidance/downloadpdf#aid35)).

29.The structural plan shape design principles set out in section 11.2, page 11.3, appear to be a requirement for all TC3 foundations. Is this the intention?

(Guidance document reference – Part C, section 11.2)

Structural plan regularity is required for all surface structures from section 15.4. For ground improvement options, either the overlying foundation or the ground improvement layout should be regular in shape. For other forms of construction, regularity is recommended but not 'mandatory' as such – but given the potential ground movements on liquefiable sites a prudent engineer would be unlikely to recommend a highly irregular floor plan.

For more information on regularity, see the supplementary guidance 'Regular structural plan shapes in TC3'.

30.The structural regularity principles set out in section 5.3, page 5.7, state:

"The representative floor plan which the development and modelling of these details has been based on is shown in Figure 5.4. The details in this section should only be applied to simple house plan shapes such as rectangular, L, T, or boomerang shapes."
Is the intention to limit floor plan regularity to the concept shown in Figure 5.4 for all of the TC2 Options 1 to 5?
(Guidance document reference – Part A, section 5.3)

The aim is to maintain compactness in the foundation layout that will allow efficient spanning of a loss in support, should this occur. It is not necessary for TC1 and TC2 foundation plans to comply rigidly with the Figure 5.4 shape. House plans that fit the criteria for structural plan regularity in section 11.2, now modified by the supplementary guidance 'Regular structural plan shapes in TC3' are expected to perform satisfactorily in future earthquake events. For more information on regularity, see the supplementary guidance 'Regular structural plan shapes in TC3'.

31. In order to achieve the MBIE Guidance target strength at seven days for cement stabilised ground improvement, the cement application rate in these soils needs to be increased (with the associated cost implications). This could be negated if the guidance could be relaxed to say achieving the criteria at 28 days. Would this be acceptable?

(Guidance document reference – Part C, section 15.3.4)

The strength needs to achieve the target strengths in the MBIE Guidance before it can be certified. In some cases it may be practical to relax the time to 28 days provided the contractor provides an undertaking to remobilise and undertake remediation of any defective works and these are completed prior to any construction of surface footings.

32. Is it anticipated that 100% of the soil tests required for ground improvement options given in the Guidance document must achieve the target criteria, or can an average value per layer be used to determine whether it is sufficient?

(Guidance document reference - Part C, section 15.3.4)

A statistical approach to soil testing is acceptable with 95% of tests exceeding the strength criteria provided that:

- this is calculated from at least 20 measurements
- that no two results which fail to exceed the criteria are adjacent (vertically or in plane) and
- no single result is less than 80% of the target strength.

33. Stand-alone garages – how close can these be built to the main house before they are not considered 'stand-alone' for the purposes of the MBIE Guidance?

(Guidance document reference – Part A, section 5.6)

900mm minimum walk space is required between cladded walls, and 300mm minimum separation at roof level.

34. Are the LiDAR horizontal movement vectors 'real'? Why do we need to design piles for 300mm movement away from lateral spread zones?

(Guidance document reference – Part B, section 8.2.5)

The LiDAR horizontal movement vectors available on the Canterbury Geotechnical Database need to be carefully interpreted. Before conclusions are drawn from this information it should be carefully considered within the context of the other available information and an understanding of the topography and driving forces for possible lateral ground movements in the area. Because of the complex analysis required to derive the horizontal vectors, the uncertainty in the horizontal displacement magnitude is about four times the uncertainty of the vertical ground level. So a typical error of about 100mm in the vertical ground level would correspond to an error of about 400mm in the horizontal ground displacement. Therefore, the LiDAR horizontal vectors are good for interpreting large lateral displacements over a wide area (eg area-wide lateral spreading along the main rivers), but are less suitable for interpreting smaller and more localised displacements.

With this limitation in mind, the EAG (Engineering Advisory Group) examined the LiDAR horizontal movement vectors, and the available crack mapping data, and identified general areas along significant waterways where there was evidence (or a reasonable possibility in a future large earthquake) of lateral ground displacements of more than 300mm occurring – this offset ranged from 50m to 200m, depending on the location (see Table 12.3). These offset distances are very generalised, and do not take into account specific geological features alongside the rivers which reduce the potential for lateral spreading (eg higher terraces of stronger soil). This assessment also identified two areas where "compressional slumping" had occurred in areas away from waterways, one in North New Brighton and one in Wainoni (see Table 12.2). These are large-scale topographic features, likely associated with historic dune formations, with about 2-3m of elevation change over about 1km distance. The topography has caused very subtle ground displacements to occur in these areas, producing only minor ground stretching, but because this small strain accumulates over a long distance it has produced significant absolute displacement in some cases.

Away from these areas of major (300-500mm) and severe (>500mm) global lateral movement, the LiDAR horizontal movement data does not have sufficient accuracy to quantify the magnitude of displacement which has occurred any more precisely. All that can be concluded with confidence from this data is that, in these areas, there has likely been less than 300mm of permanent global lateral movement over the course of the earthquake sequence. This conclusion is part of the rationale for the recommendation that all foundations in TC3 should be designed to tolerate at least 300mm global lateral displacement (or more in some areas) – there is no readily available observational dataset to subdivide TC3 further into areas with lesser design displacement.

Additionally, the potential for transient cyclic (non-permanent) displacement of liquefied ground during the course of earthquake shaking was considered when recommending the 300mm minimum design displacement value for TC3. Research by Tokimatsu & Asaka (1998) shows that peak cyclic shear strains of about 4% may occur during the course of strong shaking once loose soils liquefy. Accumulating this strain across a nominal 8m thickness of liquefied soil would result in a peak cyclic ground displacement of about 300mm.

The recommended 300mm minimum design displacement value also serves a purpose to ensure that all piles are designed to provide a reasonable minimum level of ductility or resilience, reducing the potential for undesirable brittle failure. This level of resilience is generally not difficult to achieve for well-designed piles, and there are a range of readily-available types of pile which are suitable (see Table 15.2).

Engineers with suitable competence in both of the specialised fields of earthquake geotechnical engineering and seismic pile design may choose to undertake detailed site-specific assessment of potential ground movements and specific engineering design of suitably-detailed foundations. However, engineers are cautioned that the prediction of seismic lateral ground displacements following liquefaction is subject to great uncertainties, so a careful approach to the issues identified above is recommended.

Ref: Tokimatsu, K. & Asaka, Y. (1998) "Effects of liquefaction induced ground displacements on pile performance in the 1995 Hyogoken-Nambu earthquake", Soils & Foundations, Special Issue Sept 1998, 163-177.

(https://www.building.govt.nz)35. What details are required for Type 1 and 2 surface structures for flood areas where floor levels need to be higher than maximum heights currently provided for in the Guidance?

(Guidance document reference – Part C, section 15.4)

For Type 1 surface structures, the plywood skirt is relied on to brace the foundation around the perimeter of the plan. Any higher foundation than that shown in Figure 15.16 would require the use of two horizontal runs of plywood sheets and careful detailing of force transfer at sheet junctions, and is not covered in this guidance. The use of a Type 2A or 2B surface structure is recommended in this case.

More detail is provided below regarding the permissible heights of piles above the concrete slab in Types 2A and 2B foundations to accommodate both single storey and two storey construction with medium weight claddings. The following table provides height limits for four possible pile loading conditions:

Maximum distance between top of slab and underside of joists (m)	Type 2A (150mm slab)	Type 2B (300mm slab)
Single storey light weight wall/light roof	1.00	1.15
Single storey medium weight wall/light roof	1.00	1.00
Two storey light weight wall/light roof	0.75	0.75
Two storey medium weight wall/light roof	0.60	0.60

In a case where flood requirements determine that the floor level must be higher than those given in the above table, then diagonal bracing will be required in both orthogonal directions between the piles. Details of the brace size and connections should follow those provided in NZS 3604 for braced piles. One brace in each orthogonal direction is required for every 8m^2 of floor plan for single storey construction (light and medium weight wall cladding) and one brace in each orthogonal direction for every 5m^2 of floor plan for two storey construction (light and medium weight cladding). Plywood sheathing to the perimeter of the floor may be omitted if diagonal bracing is used but diagonal braces should be fitted on the perimeter of the floor plan as much as possible. Reminder: braced piles should not penetrate the ground beyond that shown in the Type 1, or Type 2A and 2B surface structure options in the Guidance, refer Figures 15.15 to 15.20.

36. What is meant by ‘Engineer sign-off’ for TC2 sites, as indicated by the lower left box of figures 4.1 and 5.2?

(Guidance document reference – Part A, section 4.2, Figure 4.1 and section 5.1, Figure 5.2)

Engineer sign-off for TC2 sites requires a CPEng signing the shallow geotechnical investigation report to confirm the technician’s work and that the TC2 foundation repair/rebuild option is appropriate. Refer to Appendix A of MBIE’s ‘Guidance on the use of Certificates of Work, Producer Statements and Design Features Reports by Chartered Professional Engineers under the new Restricted Building Work regime’ (https://www.building.govt.nz/projects-and-consents/planning-a-successful-build/scope-and-design/choosing-the-right-people-for-your-type-of-building-work/use-licensed-people-for-restricted-building-work/restricted-building-work/)

Repairing and rebuilding houses affected by the Canterbury earthquakes (https://www.building.govt.nz/building-code-compliance/canterbury-rebuild/repairing-and-rebuilding-houses-affected-by-the-canterbury-earthquakes/)

Issue 1 - May 2013

Update 1 provides clarification and further information on technical issues relating to the residential guidance (Repairing and rebuilding houses affected by the Canterbury earthquakes). These issues result from new information or feedback received on the guidance since its publication in December 2012.

1. Can I average liquefaction settlement results across a site and compare the average to the index numbers in the guidelines?

(Guidance document reference – various)

Where calculated liquefaction settlement results exceed a specified index number in Parts A - C of the guidelines, the more conservative calculated value should be used in most cases. However, if judged appropriate by the geotechnical professional, it is possible to average calculated settlement results over a single house as long as the calculated value exceeds the specified index value by only a small amount (i.e. in the order of 10% or less). The spatial variability of the data and the potential consequences of that variability should be considered when making that judgement. It may also be possible, through additional more detailed investigation, to isolate a problem area and demonstrate that it does not affect the issue being addressed.

2. If settlements or slopes measured for a house exceed those tabulated in column 3 of Table 2.3 in section 2.3, Part A, does that automatically mean the foundations need to be rebuilt?

(Guidance document reference – Part A, section 2.3)

No. If there is an appropriate relevel or repair methodology available that can be applied practically and economically, then the preference is to repair or relevel. Table 2.3 gives indicator criteria, not absolutes, and needs to be carefully applied with consideration to a number of other factors. If the deformations are well beyond the indicator criteria in Table 2.3 then relevelling or repair may be too difficult or expensive, but there will be many cases where this is not so. However, where these indicator criteria are being exceeded by a significant amount, or a repair solution is being used that is not covered by the guidelines, the repair should be considered as a specific engineering design and appropriate documentation provided by CPEng professionals.

3. Can we use thin layer correction factors in our liquefaction calculations?

(Guidance document reference – Part C, section 13.5 and Part D, section 16.4.1 and Appendix D1)

As outlined in section 13.5.1 and 16.4.1, you cannot use thin layer correction factors if you are calculating settlement figures that you intend to compare with the index numbers in the MBIE guidelines. These sorts of corrections need to be applied with a great deal of judgement. In order to get more consistency across all professionals when they calculate index numbers, it has been decided not to include the thin layer correction factors in the MBIE guidelines methodology.

4. For subdivisions where most of the land is found to be equivalent to TC2 but some areas are found to be equivalent to TC3 performance (based on geotechnical calculations), can the results be 'averaged' and the subdivision called 'TC2-like' on

the whole?

(Guidance document reference – Part D, section 16.5)

No. The guidelines require that the subdivision is either classed conservatively as 'TC3-like', or micro-zoned on a conservative basis into multiple classifications of 'TC2-like' and 'TC3-like' behaviour. The latter classification may require additional investigation points to better identify the 'TC2-like' and 'TC3-like' areas.

5. Do I need to design piles for lateral displacement in TC1 and TC2?

(Guidance document reference – Part A, section 5.3.1, Option 5)

No. Not unless there is evidence of stretching having taken place across the site, or in the opinion of the geotechnical professional the site is obviously vulnerable to lateral stretch.

6. Do I need to use the sliding head pile detail in TC1 and TC2?

(Guidance document reference – Part A, section 5.3.1, Option 5)

Generally not. The sliding head detail is intended for TC3 sites, unless:

- there is evidence of stretching having taken place across the site, or
- in the opinion of the geotechnical professional, the site is obviously vulnerable to lateral stretch.

7. Is the sliding head detail only for certain cases of lateral stretch, and not required in other cases, or was it intended to be 'the standard detail'?

(Guidance document reference - Part C, section 15.2.5)

The sliding head detail is intended to be the standard detail for TC3 sites.

8. The sliding head detail is for cases where 'significant lateral stretch up to 200mm has occurred'. What about situations where lateral stretch is more than 200mm?

(Guidance document reference - Part C, section 15.2.5)

The MBIE solutions for deep piles do not cover situations where more than 200mm of lateral stretch, or 300mm of global lateral movement has occurred or is anticipated. Piles are not considered suitable in these situations without specific engineering design.

9. How do we design for differing depths of liquefaction versus crust thickness?

(Guidance document reference - Part C, section 15.2.5)

Under the current guidance, a designer must carry out a full kinematic interaction analysis to design for differing depths of liquefaction versus crust thickness. We anticipate that further updates will extend the current guidance to cover a slightly wider range of scenarios.

10. How does the 200mm relate to the 300mm 'lateral surface movement' that we imply in the design for the standard piles?

(Guidance document reference - Part C, section 15.2)

The 200mm relates to lateral stretch, the 300mm relates to global lateral movement.

11. We say 'where major or severe global lateral movement (>300mm) has occurred' - do we mean this, or do we mean 'or is anticipated'.

(Guidance document reference - Part C, section 15.2.2 (point 6)

We mean ‘has occurred or is anticipated’. Therefore, point 6 in section 15.2.2 should read, ‘Pile foundations are not considered suitable (without special engineering) for sites where major or severe global lateral movement (>300mm) has occurred or is anticipated (refer section 12.2)’.

12. What do the terms 'SS Sheet’ and ‘EPS’ mean?

(Guidance document reference – Part C, section 15.2.3, figure 15.3)

‘SS Sheet’ means ‘stainless steel sheet’, and ‘EPS’ means ‘expanded polystyrene’.

13. What do the letters H, M and L mean in Table 7.2, in Part A?

(Guidance document reference - Part A, section 7.8, Table 7.2)

These letters refer to cladding weights with ‘H’ meaning heavy, ‘M’ meaning medium, and ‘L’ meaning lightweight cladding. The glossary in the Reference material at the back of the guidance document gives specific definitions of the following terms: ‘heavy roof’, ‘heavy wall cladding’, ‘light roof’, ‘light wall cladding’, and ‘medium wall cladding’.

14. Ground Improvement – In Part C, section 15.3.1, the guidelines state that ‘It is intended that ground improvement carried out following these guidelines will allow the construction of either concrete or timber floors that are supported on foundations that meet the requirements of TC2.’ Does this mean that for types 1 and 2 (densified raft or stabilised crust), the depth of treatment needs to be extended beyond the specified 2 m depth to the point where the residual calculated settlements are less than 100mm (ULS) and 50mm (SLS) in the upper 10m of the soil profile?

(Guidance document reference - Part C, section 15.3)

No it does not. If the site meets the requirements of the guidance document for these ground improvement methods, then the depth of treatment needs only be to that specified in the document. (Refer to Table 15.4 for limitations).

15. Ground Improvement – can all types of ground treatment be applied on all sites?

(Guidance document reference - Part C, section 15.3.3)

No. A number of variables need to be taken into account to determine which ground improvement option to use, including soil types, site access, and potential effects of adjacent sites.

16. How do we relevel houses that are already attached to deep piles?

(Guidance document reference – Part A, section 4 and Part C, section 14)

Houses that are already supported on deep piles, where the piles have been cast into the foundation, are likely to be difficult and expensive to relevel. Consider why the piles have already failed and, once you have discovered the reason, take into account the future implications of this. If it is still considered feasible to relevel the house then, in most cases, it will be necessary to excavate beside the piles and detach them from the foundations. For internal piles this may require demolition of floor slabs although, in some cases, the floor slab piles may not be cast into the slab and therefore may not need detaching. Once detached, the foundations can be relevelled using a variety of techniques, as outlined in the guidelines. Re-establish a connection between the piles and the foundation that allows the transmission of vertical loads, and also debond the piles so that future relevelling will not require specific detachment (and to allow for possible global lateral movements if appropriate).

In some cases it might be feasible to relevel the foundations and piles using a grout injection method at the base of the piles. A specialist contractor should be consulted before recommending such a strategy.

17. The media reporting of the recent High Court case involving Tower Insurance seemed to imply that the use of injection relevelling methods was 'not allowed' – is this actually the case?

(Guidance document reference – Part A, section 4 and Part C, section 14)

No. In O'Loughlin v Tower Insurance Ltd (5 April 2013), the Court's ruling did not relate to the general viability of injection relevelling methods, which are now in common use in the Canterbury recovery. The ruling, which Justice Asher emphasised was specific to the case and evidence presented, related to the insurance company's contractual obligations for payment of a particular insurance claim.

The decision whether to use an injection relevelling method for a repair should be determined based on the particular circumstances. In many cases, injection methods will be a viable, consentable solution for the relevelling of a building. Section 4 of Part A and section 14 of Part C of the guidance provide information to be considered when repairing foundations and considering relevelling options.

18. For Port Hills properties, does the presence of the Green Zone mean that we do not need to consider rockfall hazards or other external hazards that might affect a site?

(Guidance document reference – Part A, section 6)

No. The Green Zone does not diminish the normal obligation to consider and assess natural hazards that might affect the site, both from sources external and internal to the site boundaries. The Port Hills zoning considers the exposure of risk to life rather than property damage; a site may have particular local features that still render it vulnerable to natural or manmade hazards such as rockfall or land instability.

19. Regularity – Given that a 2:1 ratio base plan is allowed, and a 1:1 main projection, does this allow the combination of the two, along the long axis of the building to give an overall 3:1 aspect ratio rectangular building plan?

(Guidance document reference – Part C, section 11.2)

No. This goes against the obvious intent of the regularity guidelines. The 1:1 major projection needs to come off the long side of the base plan.

Repairing and rebuilding houses affected by the Canterbury earthquakes (https://www.building.govt.nz/building-code-compliance/canterbury-rebuild/repairing-and-rebuilding-houses-affected-by-the-canterbury-earthquakes/)
