EVALUATION REPORT AND CHECKLIST

engineering new zealand
te ao rangahau

CONTENTS

INTRODUCTION

It contains tools and templates to aid engineers when reviewing designs and conveying their findings to councils and property owners. While we've provided as much information as possible, engineers are expected to use their expertise to understand if additional resources are required or if the project falls outside the scope of the information available.

The document may be revised as we gather additional feedback; we advise checking for updates.

INITIAL REVIEW

PROPERTY ADDRESS

Description of property and site[1]	*eg standalone house, site slope approx. 15deg from left to right.*
Foundation type	*eg slab on grade*
Building type and construction	*eg lightweight timber frame, brick clad, built 2021*

JOB TYPE

Project phase: During construction ☐ **CCC Phase** ☐ **Building Consent** ☐ **CCC Issued – unsure.** ☐

Initial appraisal ☐ **Review with no site visit** ☐ **Review with site visit** ☐

Urgent request (please explain) ☐ *eg failing under construction or showing obvious signs of failure*

Is the property tenanted? Yes ☐ No ☐

Tenant name(s) (if applicable)	

PROPERTY OWNER(S)

Name(s)	

REVIEW SCOPE

Please describe the original design scope and what you are reviewing

Eg The elements covered by the original PS1 and reviewed as part of this triage review are as follows:

- *Deck and alfresco post foundations, raft slab foundations*
- *Deck bracing posts and alfresco bracing posts, beams, lintels and connections*
- *Deck bracing, deck posts and alfresco bracing posts*

Elements not reviewed

- *Proprietary and non-SED elements (NZS3604 elements)*
- *All other elements.*
- *Another engineer designed stairs*

House bracing by architect

[1] Append images to the report.

RECOMMENDATIONS

Please detail any further investigations you consider are necessary or potential options for any remediation required.

Eg Recommended action for the______ to consider:

- *Based on the information provided, the building work is classified **Medium** risk*
- *Several floor beams have been designed incorrectly, with unconservative loads. However, the beam sizes appear appropriate based on the sizes and span*
- *The alfresco area has not been designed correctly, with incorrect load derivation and the loads not applied correctly to the post. The alfresco posts are undersized based on the 89x5 SHS shown on the drawings, which fails both ULS and SLS design criteria. It, however appears roof bracing has been installed in the alfresco area, which will provide some restraint to the top of the posts, the roof framing will also provide some additional support to the posts. With restraint at the top of the posts, the demands reduce considerably and the ULS criteria appears to be satisfied for the posts. There may also be the added benefit of the decking acting as a diaphragm to restrain the posts further at floor level and help transfer load back to the dwelling. The bracing plans suggest some bracing located along FFE and GFE to help resist the loads being transferred from the alfresco. As the dwelling is effectively bracing the whole alfresco, the bracing may be inadequate along these brace lines Despite the possible load paths, SLS may still be an issue. The load paths described rely on adequate load paths through connections, which cannot be confirmed from sheet 19 and without further information of inspection records*
- *The ______ should investigate whether a 125x5 SHS was installed or the 89x5SHS as per the drawings. Should the 125x5 SHS be installed, this should avoid a ULS failure, however SLS issues may be experienced*
- *The deck post has been considered as a cantilever to brace the deck. The calculations are incorrect, however the deck appears to be braced on two sides by the dwelling, therefore it is likely the dwelling will provide restraint to the deck, avoiding the need to rely on the small SHS posts for bracing. The ______ should check the inspection records to confirm these connections have been constructed and the house is able to provide restraint to the deck*
- *The slab provided resembles a standard Firth Rib-raft slab with similar detailing for load bearing elements and slab thickenings. Bearing pressures appear within typical ranges for a structure of this nature*
- *We recommend the owner supplies the geotechnical report, or commissions another report to ensure a standard rib-raft has been recommended and confirms the bearing capacity of the soil exceeds those determined in the calculations. The site inspection records should also be checked to confirm any site preparation was completed as per the geotechnical report*
- *We recommend site inspections by a CPEng to check as-built compared to design and confirm assumptions to provide more accurate recommendations*
- *We recommend the BCA reviews inspection records to confirm reinforcing placement has been correctly installed, ensuring correct cover and construction is as per firths technical manual guidelines*

CHECKLIST

- ☐ I have enclosed the relevant report(s)
- ☐ I have explained my services to the property owner
- ☐ I have explained any costs to the property owner
- ☐ I have explained my recommendation to the property owner

QUESTIONS

Please list any questions or issues the homeowner or BCA would like addressed.

LIST OF DOCUMENTATION REVIEWED

Calculations dated and numbered	
Drawings dated and numbered	
Geotechnical report (if applicable) reference	
Consent document	
Other	
What has not been reviewed?	*Eg My technical input is based solely on a review of the available engineering reports and a non-intrusive assessment of the property.*
Signed by (Name and signature of Design Review Professional)	
CPEng #	
ON BEHALF OF (Review Firm)	

Note: This statement has been prepared solely for (named above) and shall not be relied upon by any other person or entity. Any liability in relation to this statement accrues to the Review Firm only. As a condition of reliance on this statement, accepts that the total maximum amount of liability of any kind arising from this statement and all other statements provided to in relation to this report, whether in tort or otherwise, is limited to the sum of $200,000.

APPENDIX 1 – DETERMINING THE RISK, CONSEQUENCE, ACTION REQUIRED AND TIMEFRAME

To accurately convey information, we need to address the following factors:

1. What is the hazard?
2. What is the consequence of failure under varying conditions?
3. What is the likelihood of occurrence?
4. What has to be done to address the hazard?
5. What is the timeframe for addressing the hazard?

HAZARD

A hazard is a potential source of harm. Substances, events, or circumstances can constitute hazards when their nature would allow them, even just theoretically, to cause damage to health, life, property, or any other interest of value.

RISK

A general definition of risk used widely is:

- Risk type = f(Probability, Consequence)

Probability

We can use annual probability of exceedance measures from AS/NZS 1170 as a baseline for probability of a fault being mobilised, and then think about a possible consequence.

- SLS = Commonly occurring condition or load case
- ULS = Rare events
- MCE = Backstop protection against disproportionate collapse or other catastrophic cases

Consequence

We can consider probability and consequence against four factors:

1. Life safety
2. Protection of property
3. Loss of amenity
4. Loss of access

Timeframe

What is the timeframe for the hazard to be repaired or replaced?

For example, is there an immediate life safety risk? Will the structure need remediation before it can be used again, or can it be used until it is repaired? High and Very High risks are likely to need immediate repair.

APPENDIX 2 – RISK LEVEL TABLE

Table 1 can be used to evaluate the structures' risk level and elements. We've included a completed example and a blank template for you to use.

Table 1: Risk level

	Very High	High	Medium	Low
Life Safety	*Collapse hazards on site (eg cantilevered precast panels with inadequate connections, concrete flat slabs with inadequate connections)*	*Barriers incorrectly designed (egcar deck, veranda, retaining wall)*	*Inadequate support specified under load-bearing element or inadequate foundation design*	*Underestimation of the design load, but member sizes appear sufficient (eg roof and floor dead loads are underestimated, but roof/floor beams have adequate capacity)*
		Severe design errors. Incomplete gravity and/or lateral load path	*Significant deviations from required load capacities*	*Over-reinforced reinforced masonry walls suffer brittle failure*
Protection of property	*Global instability – particularly when affecting neighbouring properties – possibly signs of potential collapse in soil*	*The driveway/boundary retaining wall is under-designed, possibly showing signs of distress (movement, cracking)*	*Geotechnical recommendations have not been followed, leading to instability, settlement, or failure of the foundation system*	*The designer has completed the geotechnical investigation, or the geotechnical recommendations have not been strictly followed*
		Elements supporting cladding are very flexible. May allow water ingress	*Element durability not specified correctly*	*Incompatible bracing systems (eg portal frames are incompatible with LTF bracing elements) may cause excessive damage in seismic events*
Loss of amenity	*Global instability – particularly when affecting neighbouring properties – possibly signs of potential collapse in soil*	*Inadequate foundation design leads to slumping foundations*	*Inadequate support specified under a load-bearing element or inadequate foundation design*	*Underestimation of the design load, but member sizes appear sufficient (eg roof and floor dead loads are underestimated, but roof/floor beams have adequate capacity)*
		Barriers incorrectly designed (eg, car deck, veranda, retaining wall)	*Moderate serviceability issues (eg span/depth ratios outside the typical range,*	*The designer has completed the geotechnical investigation incorrectly (see*

			vibration may become an issue)	***[NZGS/NZGS guideline]()**)*
Loss of access	*Driveway/boundary retaining wall under-designed, possibly showing signs of distress (movement, cracking) affecting neighbouring properties*	*The driveway/boundary retaining wall is under-designed, possibly showing signs of distress (movement, cracking)*	*The designer has incorrectly completed the geotechnical investigation, or the geotechnical recommendations have not been strictly followed*	*The designer has completed the geotechnical investigation. Appears to be ok to* ***NZGS/ENZ guideline***
	Access to property (eg, walkways, pedestrian bridges) under designed/not designed			

	Very High	High	Medium	Low
Life Safety				
Protection of property				
Loss of amenity				
Loss of access				

APPENDIX 3 – EVALUATION TABLE

Table 2 can be used to capture and evaluate hazards. We've included a completed example and a blank template for you to use.

Table 2: Evaluation

Hazard	*Soft Soil*
Issue	*Testing carried out during the placement of site fill appears to show softer ground than the other testing.*
Evidence	*The e-mail from XXXXX shows materially different test results from the XXXXX geotechnical report, and the XXXXX Liquefaction assessment.*
Consequence of failure	• *Potential for building settlement*
SLS	*Settlement may occur*
ULS	*No ULS risk*
Risk evaluation	*Very low*
Investigation required	*Scala testing and a hand auger should be carried out to validate the original soil investigation results.* *A floor level survey should be conducted to establish an existing baseline against any future measurements.*
Potential remedial work	*If the original investigation reflect the ground conditions then no remedial work is required.* *If the very low strengths from the e-mail are correct then geotechnical advice should be sought,*
Timeframe	*Settlement occurs slowly, so it may be years before any inherent soft spots become significant. Structural repairs could be progressive as damage occurs, by injection-grouting any visible cracks.*

Hazard	
Issue	
Evidence	
Consequence of failure	
SLS	
ULS	
Risk evaluation	
Investigation required	
Potential remedial work	
Timeframe	

APPENDIX 4 – ABBREVIATED CHECKLIST

Table 3 provides a way to check for many errors engineers have found. We've included a completed example and a blank template for you to use. We recommend reading through the full checklist (Appendix 5) and incorporating any additional factors for the project under review. Also, see the list of common errors in Appendix 6.

Table 3: Abbreviated review

	Comment *(examples below)*
Is the geotechnical report appropriate for the site?	*PS1 references a geotechnical report by ………..). This has not been supplied, so unable to review the design requirements of the site*
Does the foundation design match the Geotech report? Was geotechnical improvement implemented?	*1. Geotechnical ultimate bearing capacity of 300kPa (150kPa factored)* *2. No load derivations for the slab have been supplied in the calculations. However, based on input loads, the highest bearing stress is 76kPa*
Check the retaining wall loads, soil values, slope, and surcharge. Stepped retaining walls considered?	*N/A*
Trace the gravity load path – roof to foundations. Capacity and connections	*1. Dead loading for roof and floor beams appears to be underestimated. No justification has been provided, and the loads are less than the assumed loads in Section 3.2.3 of the Engineering Basis of NZS3604* *2. L02 has been designed as a 240x90 however the plans specify 240x45* *3. L03 has not considered the point load from FB01 for live loads which will considerably understate the loads applied to L03* *4. The engineer has designed the alfresco post as a 125x5SHS however 90x5 SHS is specified on the drawings, the analysis is oversimplified and does not reflect the structural system presented*
Lateral system – check windspeed and seismic coefficients. Check that the loads used in bracing calculations are correct. Portal frame ductility.	*1. Seismic derivation for bracing posts has considered the incorrect ductility, therefore understating the loads by a factor of approximately 1.8* *2. The alfresco bracing has not considered the load from the roof at the roof level. This has been considered at the first-floor level, therefore understating the demand in the post* *3. The engineer has taken half the load back to the house but provided no justification* *4. Wind loading for the alfresco has not been considered, and seismic loads are unconservative*
Do the spreadsheet calculations match the drawings?	*Spreadsheets have soil angles listed. However, the spreadsheet does not alter to take the additional load*
Serviceability OK? Limits defined? Portal frame, wind beams, studs beside large openings.	*Excessive deflection of elements supporting cladding or windows. SLS deflection of studs = 1/_____*

Check that the connection details are drawn, and that there is a robust load path.	*Connections under-designed or not designed - steel to stud details not supplied*
Is durability specified? Is it correct?	1. *Galvanised plates (Bowmac and custom plates) and bolts specified with tantalised timber. These are incompatible materials* 2. *The treatment of the SHS posts is not clear, painting or galvanising is required for compliance with B2*
Are neighbouring properties affected?	*No inter-tenancy walls or retaining walls on the boundary*
What are the items on the original PS1? Checked?	*Foundations, beams, bracing of the deck*

	Comment
Is the geotechnical report appropriate for the site?	
Does the foundation design match the Geotech report? Was geotechnical improvement implemented?	
Check the retaining wall loads, soil values, slope, and surcharge. Stepped retaining walls considered?	
Trace the gravity load path – roof to foundations. Capacity and connections	
Lateral system – check windspeed and seismic coefficients. Check that the loads used in bracing calculations are correct. Portal frame ductility.	
Do the spreadsheet calculations match the drawings?	
Serviceability OK? Limits defined? Portal frame, wind beams,	

studs beside large openings.	
Check that the connection details are drawn, and that there is a robust load path.	
Is durability specified? Is it correct?	
Are neighbouring properties affected?	
What are the items on the original PS1? Checked?	

APPENDIX 5 – COMPREHENSIVE CHECKLIST

The table below is based on Engineering New Zealand Tips and Tricks – Structural, NZSEE Technical Guidelines Part B – Initial Seismic Assessment, and SESOC's Design Review Guide and BOKS document). It provides a more thorough process for reviewing work.

• Criterions	• Review Checklist
Loading (Design Feature Report) includes:	• Detailed and concise DFR provided • Dead, superimposed, live distributed and point loads (plant, storage, plantation, vehicle etc.) • Vehicle barrier impact loads and application point, pedestrian balustrade loads • Retaining wall soil strength parameters and horizontal loading pressure coefficients • Base site wind loads • Earthquake ductility, period, base shear coefficient, seismic weight, site class • Parts acceleration and factors
Load Paths include:	• Direct/non-convoluted vertical and horizontal load paths all the way to the ground. If load paths are difficult to hand analyse intuitively, recommend full peer review at an early stage • No missing load paths • No accidental brittle failure links in the load path chain, ie premature flexural buckling of portal frame rafters when mu>1.25 is adopted • Ductility adopted matches the detailing utilized • Mixed stiffness/ductility systems with transfer diaphragms • Possible failure mechanisms and their resilience for higher loads/displacements for mu>1.25 design, ie resilience present • Displacement incompatibility between other structural elements or external restraints • No substantial horizontal and vertical irregularity, see NZSEE Assessment Guidelines Part B, Table BA.4 • Staged construction temporary load cases considered (Erection methodology, sequence, temporary propping and bracing of structure & soil considered at a performance specification level. These items should be covered in detail by a separate temporary works consent as well) • Assumed external restraint locations are adequate, ie in a sloping front face of retaining wall scenario
Sizing (Design)	• Strength hierarchy (weak beam/strong column) • Protected members are sized to overstrength of yielding members

	• Member sizes matches the ductility chosen • Member sizes match those on other similar projects, cross-check • Soft storey or torsional potential post-yielding not present • Serviceability performance in deflections and vibrations • Maximum deflections, P-Delta/delta effects, pounding potential (ie neighbouring building response is considered) • Sizing and detailing of critical elements that have high load concentrations. Recommended to perform ‘back of the envelope’ type calculations or review designer detailed calculations • Adequate layout and reinforcing of diaphragms
Detailing	• Redundancy and ductility in connections • Minimum actions for steel and timber connections • Minimum edge distances for bolts and concrete anchors • Maximum and minimum reinforcement quantities for concrete • Reinforcement for shrinkage, thermal and flexural cracking • Adequate confinement of concrete and anti-buckling restraint to longitudinal bars • Concrete strength & covers for durability and fire • Anchorage lengths on hooks and laps • Buildability, i.e., flow of concrete, feasibility of butt welds etc • Safety in design for aspects of construction and maintenance • Connection details match the calc assumptions ie pin or fixed • Dis-similar materials, ie aluminium in concrete, SS steel with mild steel not utilized • Typical details and location for control joints in masonry and saw cuts in concrete slabs • Lateral restraint of beams and columns from premature flexural or axial buckling, and adequate fixity at their ends • Missing primary structure details • Penetrations through beams and floors are adequately located and reinforced • ‘Gut’ level comparison of details to other similar projects and SCNZ tabulated connections • Eccentricity in connections has been designed for • Inter-storey displacement allowances in stairs, precast floor seating and façade elements

	• Adequate fixings to diaphragms • Adequate reinforcement for potential severe structural weaknesses, ie punching shear in suspended slabs, shear and buckling of columns
Documentation (Specifications/Geotechnical/Architectural)	• Works specification contains material/workmanship quality control requirements for the trades being utilized • Specification or DFR provides method of compliance to B2 for all structural materials and a maintenance schedule is provided • Procurement and quality control of steel sourced internationally, SCNZ system has been documented • Geotech report is up to date and relevant to the proposed structural development • Geotech report is complete and addresses soil slope failure, lateral spread and associated loading on foundations, liquefaction, displacements, soil stiffness, active and passive pressure parameters etc • Structural engineer has applied all loading and design requirement of the Geotech report • Calculation pack is complete for all elements • Adequate CM level of monitoring is specified • Proprietary design elements, their design performance specifications and supplier construction specifications • Layout of the structure and loads match those shown in the architectural drawings

APPENDIX 6 – EXAMPLES OF COMMON DESIGN MISTAKES FOUND

DURABILITY

- Element durability not specified correctly
- Excessive deflection of elements supporting cladding or windows
- Galvanized brackets and anchors into tantalized timber

LOADS

Horizontal

- Wind loads have been calculated, may be incorrect, or the numbers have not been used in bracing calculations
- Seismic coefficients have been incorrectly calculated – if correct may not match with the coefficient used for bracing calculations

Vertical

- Tributary widths and line/point loads incorrect or missing
- Wind loads may not have been applied – uplift
- Incorrect live loads applied – particularly storage areas
- Gravity loads for roof and floors below NZS3604 engineering basis values
- Self-weight usually not considered for concrete beams

BEAMS

- Beams undersized for span and load
- Not checking SLS for vibration, flexibility or lack of wind beams
- Wind loads may not have been applied – uplift
- Spreadsheet for beam design doesn't provide correct values when you enter the same values as considered
- Face Loding not checked for wind beams

BRACING

- Incorrect calculation horizontal loading – eg wind zones and seismic co-efficient
- Incompatible bracing system (eg portal frames are not compatible with LTF bracing elements)
- Load paths outside the scope of NZS3604 with no justification (eg large diaphragms)
- Portal frame ductility incorrect - has not changed u = 3.5 to u = 1.25 (see **Engineering New Zealand guidance document** on the design of residential portals
- Bracing designed for various ductility's (M=3.5,2.0)

SAFETY FROM FALLING

Barriers incorrectly designed (eg car deck, verandah, retaining wall) – check that the design loads are applied, and the structure can transfer the load with a robust load path (connections, back-span)

CONNECTION DETAILING

- Lack of connection details in drawings (missing or incorrect)

- Connections under-designed or not designed – eg – not detailing for steel to stud or the number of supporting studs
- Hold-down bolts – check edge distances
- Double studs are used for large loads (30kN +) instead of triple studs or steel posts
- Green factor for bolts is not considered

GEOTECHNICAL

Retaining walls

- Pole embedment is often taken as the retained height
- Retaining walls are undersized because (for example):
    - the spreadsheets have soil angle listed; however, the spreadsheet does not alter to take the additional load
    - May have stacked retaining walls without considering cumulative actions
    - Large back slopes not considered or below what is on site
    - Surcharge loads are not considered (e.g., house or driveway above the wall)
    - No K factors are taken into consideration for poles (shaving etc.)
    - Bending not taken below ground as per VM4
    - The calculated retaining wall height does not match the drawn height
- Steel is commonly drawn centrally in retaining walls (or notes 60mm cover) – the drawn steel setback doesn't match the calculations
- Retaining walls have not taken concrete crushing (brittle failure) into consideration
- Rails specified in design as double below a certain height. However, only single rails are shown in drawings
- No bearing checks for masonry walls

Foundations

- The foundation design is inadequate and/or does not match the parameters on the geotechnical report
- Inadequate support specified under load-bearing element or inadequate foundation design
- Geotechnical report incorrect or insufficient (see NZGS/Engineering New Zealand guidance)
- Incorrect reinforcement - ground beams
- Geotechnical improvement has not been installed when required by the geotechnical report
- Cantilevered spanning of drains - may not take back span into account
- No piles under point loads