CHRISTCHURCH CITY COUNCIL
PRK_1385_BLDG_005 EQ2
Bexley Park Underground Bunker
194 Bexley Road, Bexley

QUANTITATIVE ASSESSMENT REPORT

FINAL

- Rev B
- 04 March 2013

CHRISTCHURCH CITY COUNCIL
PRK_1385_BLDG_005 EQ2
Bexley Park Underground Bunker
194 Bexley Road, Bexley

QUANTITATIVE ASSESSMENT REPORT

FINAL

- Rev B
- 04 March 2013

Sinclair Knight Merz
142 Sherborne Street
Saint Albans
PO Box 21011, Edgeware
Christchurch, New Zealand
Tel: +64 3 940 4900
Fax: +64 3 940 4901
Web: www.skmconsulting.com

Contents

1. Executive Summary 1
 1.1. Background 1
 1.2. Key Damage Observed 1
 1.3. Critical Structural Weaknesses 2
 1.4. Indicative Building Strength 2
 1.5. Recommendations 2
2. Introduction 4
3. Compliance 5
 3.1. Canterbury Earthquake Recovery Authority (CERA) 5
 3.2. Building Act 6
 3.3. Christchurch City Council Policy 7
 3.4. Building Code 8
4. Earthquake Resistance Standards 9
5. Building Details 11
 5.1. Building description 11
 5.2. Gravity Load Resisting system 11
 5.3. Seismic Load Resisting system 11
 5.4. Building Damage 11
6. Quantitative Assessment 13
 6.1. Available Information 13
 6.2. Survey 13
 6.3. Assumptions 13
 6.4. The Detailed Engineering Evaluation (DEE) process 14
 6.5. Critical Structural Weaknesses 16
 6.6. Analysis Results 17
 6.7. Recommendations 17
7. Further Investigation 19
8. Conclusion 20
9. Limitation Statement 22
10. Appendix 1 – Photos 23
11. Appendix 2 – CERA Standardised Report Form 27

SINCLAIR KNIGHT MERZ
SKM

Document history and status

Revision	Date issued	Reviewed by	Approved by	Date approved	Revision type
A	06/11/2012	G. Fletcher	N. Calvert	06/11/2012	Draft for Client Approval
B	04/03/2013	N Calvert	N Calvert	04/03/2013	Final Issue

Approval

	Signature	Date	Name	Title
Author		04/03/2013	Willow Patterson-Kane	Structural Engineer
Approver		04/03/2013	Nick Calvert	Senior Structural Engineer

Distribution of copies

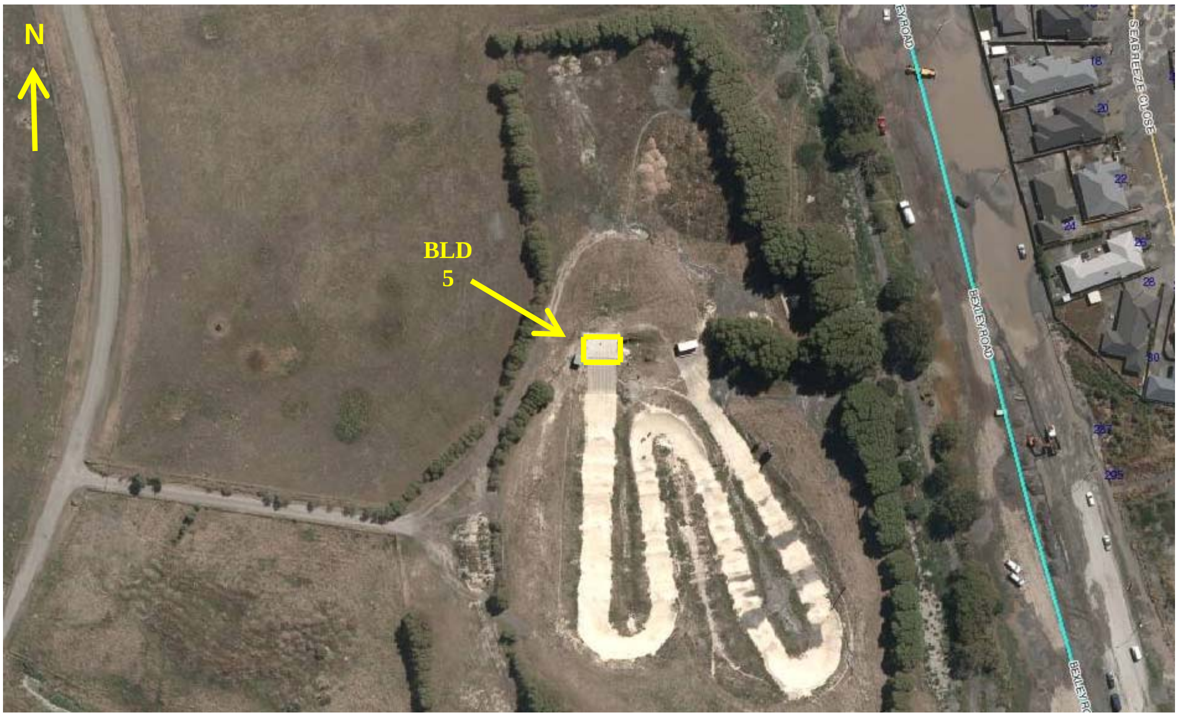
Revision	Copy no	Quantity	Issued to
A	1	1	CCC
B	1	1	CCC

Printed:	4 March 2013
Last saved:	4 March 2013 02:24 PM
File name:	ZB01276.169_CCC_PRK_1385_BLDG_005 EQ2 Combined Assmt.B.docx
Author:	Willow Patterson-Kane
Project manager:	Nick Calvert
Name of organisation:	Christchurch City Council
Name of project:	Christchurch City Council Structures Panel
Name of document:	Bexley Park Underground Bunker Quantitative Assessment
Document version:	B
Project number:	ZB01276.169

1. Executive Summary

1.1. Background

A quantitative assessment was carried out on the building located at the BMX track in Bexley Park near 194 Bexley Road, Bexley. The building is single storey and doesn't currently appear to be in use. It was assumed to be utilised as a shelter for the BMX track. It is constructed from a shipping container, with a concrete slab on top that is incorporated into the BMX track. An aerial photograph illustrating these areas is shown below in Figure 1. Detailed descriptions outlining the buildings age and construction type is given in Section 5 of this report.



- **Figure 1 Aerial Photograph of the underground bunker at Bexley Park**

This quantitative report for the building structure is based on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011, a visual inspection on 18 June 2012 and calculations.

1.2. Key Damage Observed

Key damage observed includes:-

- Structural instability of timber retaining wall.
- Inwards buckling of building walls on the south and east walls.

1.3. Critical Structural Weaknesses

No potential critical structural weaknesses have been identified for this building. However it should be noted that the instability of the southern timber retaining wall at the entrance to the structure creates a collapse hazard.

1.4. Indicative Building Strength

As described in the Engineering Advisory Group's "Guidance on Detailed Engineering Evaluation of Earthquake Affected Non-residential Buildings" (from July 2011) we have assessed the percentage of new building standard seismic resistance using the quantitative method. Our assessment included consideration of geotechnical conditions, existing earthquake damage to the building and structural engineering calculations to assess both strength and ductility/resilience.

The assessments were based on the following:

- On-site investigation to assess the extent of existing earthquake damage.
- Quantitative assessment based on external visual inspection only as drawings were not available, and the building was not accessible due to the structural instability of the retaining wall at the entrance to the building.
- No geotechnical investigation has been undertaken. We have based this report on our knowledge of the site and the absence of liquefaction ejecta on the site.
- Assessment of the strength of the existing structures taking account of the current condition.

Any building that is found to have a seismic capacity less than 34% of the new building standard is required by law to be strengthened up to a capacity of at least 67% NBS.

Based on the information available, and using the Quantitative Assessment Procedure, the buildings original capacity has been assessed to be in the order of 46% NBS and post earthquake capacity in the order of 10% NBS.

The building has been assessed to have a seismic capacity less than 33% NBS and is therefore considered to be earthquake prone, this is based on the southern timber retaining wall at the eastern entrance. It is worth noting that this assessment was made with partial structural drawings and is accordingly limited.

1.5. Recommendations

Based on the findings of the assessment, we have provided recommendations for improvement of the retaining wall since it is earthquake prone. While the superstructure of the building is not earthquake prone, the site has a moderate to severe liquefaction risk, and hence the (lack of) foundations cause the building to be earthquake prone and therefore strengthening is recommended.

It is recommended that:

a) The building is unsafe to occupy on the basis of the instability of the southern retaining wall.
b) We consider that barriers around the building are necessary due to the collapse hazard represented by the south retaining wall.

2. Introduction

Sinclair Knight Merz was engaged by Christchurch City Council to carry out a quantitative assessment of the seismic performance of the building located at the BMX track in Bexley Park near 194 Bexley Road.

The scope of the quantitative analysis includes the following:

- Analysis of the seismic load carrying capacity of the building compared with current seismic loading requirements or New Buildings Standard (NBS). It should be noted that this analysis considers the building in its damaged state where appropriate.
- Identify any critical structural weaknesses which may exist in the building and include these in the assessed %NBS of the structure.
- Preparation of a summary report outlining the areas of concern in the building as well as identifying strengthening concepts to 67%NBS for any areas which have insufficient capacity if the building is found to be an earthquake prone building.

The recommendations from the Engineering Advisory Group[1] were followed to assess the likely performance of the structures in a seismic event relative to the New Building Standard (NBS). 100% NBS is equivalent to the strength of a building that fully complies with current codes. This includes a recent increase of the Christchurch seismic hazard factor from 0.22 to 0.3[2].

At the time of this report, no intrusive site investigation has been carried out. Our evaluation of the building is accordingly limited as the result of not having access to structural drawings for this building. The building description in Section 5 is based on our visual inspections only.

---

[1] EAG 2011, *Guidance on Detailed Engineering Evaluation of Earthquake Affected Non-residential Buildings in Canterbury - Draft*, p 10

[2] http://www.dbh.govt.nz/seismicity-info

3. Compliance

This section contains a brief summary of the requirements of the various statutes and authorities that control activities in relation to buildings in Christchurch at present.

3.1. Canterbury Earthquake Recovery Authority (CERA)

CERA was established on 28 March 2011 to take control of the recovery of Christchurch using powers established by the Canterbury Earthquake Recovery Act enacted on 18 April 2011. This act gives the Chief Executive Officer of CERA wide powers in relation to building safety, demolition and repair. Two relevant sections are:

Section 38 – Works

This section outlines a process in which the chief executive can give notice that a building is to be demolished and if the owner does not carry out the demolition, the chief executive can commission the demolition and recover the costs from the owner or by placing a charge on the owners' land.

Section 51 – Requiring Structural Survey

This section enables the chief executive to require a building owner, insurer or mortgagee carry out a full structural survey before the building is re-occupied.

We understand that CERA will require a detailed engineering evaluation to be carried out for all buildings (other than those exempt from the Earthquake Prone Building definition in the Building Act). It is anticipated that CERA will adopt the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011. This document sets out a methodology for both qualitative and quantitative assessments.

The qualitative assessment is a desk-top and site inspection assessment. It is based on a thorough visual inspection of the building coupled with a review of available documentation such as drawings and specifications. The quantitative assessment involves analytical calculation of the buildings strength and may require non-destructive or destructive material testing, geotechnical testing and intrusive investigation.

It is anticipated that factors determining the extent of evaluation and strengthening level required will include:

- The importance level and occupancy of the building
- The placard status and amount of damage
- The age and structural type of the building

- Consideration of any critical structural weaknesses
- The extent of any earthquake damage

3.2. Building Act

Several sections of the Building Act are relevant when considering structural requirements:

3.2.1. Section 112 – Alterations

This section requires that an existing building complies with the relevant sections of the Building Code to at least the extent that it did prior to any alteration. This effectively means that a building cannot be weakened as a result of an alteration (including partial demolition).

3.2.2. Section 115 – Change of Use

This section requires that the territorial authority (in this case Christchurch City Council (CCC)) be satisfied that the building with a new use complies with the relevant sections of the Building Code 'as near as is reasonably practicable'. Regarding seismic capacity 'as near as reasonably practicable' has previously been interpreted by CCC as achieving a minimum of 67%NBS however where practical achieving 100%NBS is desirable. The New Zealand Society for Earthquake Engineering (NZSEE) recommend a minimum of 67%NBS.

3.2.3. Section 121 – Dangerous Buildings

The definition of dangerous building in the Act was extended by the Canterbury Earthquake (Building Act) Order 2010, and it now defines a building as dangerous if:

- in the ordinary course of events (excluding the occurrence of an earthquake), the building is likely to cause injury or death or damage to other property; or
- in the event of fire, injury or death to any persons in the building or on other property is likely because of fire hazard or the occupancy of the building; or
- there is a risk that the building could collapse or otherwise cause injury or death as a result of earthquake shaking that is less than a 'moderate earthquake' (refer to Section 122 below); or
- there is a risk that that other property could collapse or otherwise cause injury or death; or
- a territorial authority has not been able to undertake an inspection to determine whether the building is dangerous.

3.2.4. Section 122 – Earthquake Prone Buildings

This section defines a building as earthquake prone if its ultimate capacity would be exceeded in a 'moderate earthquake' and it would be likely to collapse causing injury or death, or damage to other property. A moderate earthquake is defined by the building regulations as one that would generate ground shaking 33% of the shaking used to design an equivalent new building.

3.2.5. Section 124 – Powers of Territorial Authorities

This section gives the territorial authority the power to require strengthening work within specified timeframes or to close and prevent occupancy to any building defined as dangerous or earthquake prone.

3.2.6. Section 131 – Earthquake Prone Building Policy

This section requires the territorial authority to adopt a specific policy for earthquake prone, dangerous and insanitary buildings.

3.3. Christchurch City Council Policy

Christchurch City Council adopted their Earthquake Prone, Dangerous and Insanitary Building Policy in 2006. This policy was amended immediately following the Darfield Earthquake of the 4th September 2010.

The 2010 amendment includes the following:

- A process for identifying, categorising and prioritising Earthquake Prone Buildings, commencing on 1 July 2012;
- A strengthening target level of 67% of a new building for buildings that are Earthquake Prone. Council recognises that it may not be practicable for some repairs to meet that target. The council will work closely with building owners to achieve sensible, safe outcomes;
- A timeframe of 15-30 years for Earthquake Prone Buildings to be strengthened; and,
- Repair works for buildings damaged by earthquakes will be required to comply with the above.

The council has stated their willingness to consider retrofit proposals on a case by case basis, considering the economic impact of such a retrofit.

We anticipate that any building with a capacity of less than 33%NBS (including consideration of critical structural weaknesses) will need to be strengthened to a target of 67%NBS of new building standard as recommended by the Policy.

If strengthening works are undertaken, a building consent will be required. A requirement of the consent will require upgrade of the building to comply 'as near as is reasonably practicable' with:

- The accessibility requirements of the Building Code.

- The fire requirements of the Building Code. This is likely to require a fire report to be submitted with the building consent application.

3.4. Building Code

The building code outlines performance standards for buildings and the Building Act requires that all new buildings comply with this code. Compliance Documents published by The Department of Building and Housing can be used to demonstrate compliance with the Building Code.

After the February Earthquake, on 19 May 2011, Compliance Document B1: Structure was amended to include increased seismic design requirements for Canterbury as follows:

a) Hazard Factor increased from 0.22 to 0.3 (36% increase in the basic seismic design load)
b) Serviceability Return Period Factor increased from 0.25 to 0.33 (80% increase in the serviceability design loads when combined with the Hazard Factor increase)

The increase in the above factors has resulted in a reduction in the level of compliance of an existing building relative to a new building despite the capacity of the existing building not changing.

4. Earthquake Resistance Standards

For this assessment, the building's earthquake resistance is compared with the current New Zealand Building Code requirements for a new building constructed on the site. This is expressed as a percentage of new building standard (%NBS). The new building standard load requirements have been determined in accordance with the current earthquake loading standard (NZS 1170.5:2004 Structural design actions - Earthquake actions - New Zealand).

The likely capacity of this building has been derived in accordance with the New Zealand Society for Earthquake Engineering (NZSEE) guidelines 'Assessment and Improvement of the Structural Performance of Buildings in Earthquakes' (AISPBE), 2006. These guidelines provide an Initial Evaluation Procedure that assesses a buildings capacity based on a comparison of loading codes from when the building was designed and currently. It is a quick high-level procedure that can be used when undertaking a Qualitative analysis of a building. The guidelines also provide guidance on calculating a modified Ultimate Limit State capacity of the building which is much more accurate and can be used when undertaking a Quantitative analysis.

The New Zealand Society for Earthquake Engineering has proposed a way for classifying earthquake risk for existing buildings in terms of %NBS and this is shown in Figure 2 below.

Description	Grade	Risk	%NBS	Existing Building Structural Performance	Improvement of Structural Performance	
					Legal Requirement	NZSEE Recommendation
Low Risk Building	A or B	Low	Above 67	Acceptable (improvement may be desirable)	The Building Act sets no required level of structural improvement (unless change in use) This is for each TA to decide. Improvement is not limited to 34%NBS.	100%NBS desirable. Improvement should achieve at least 67%NBS
Moderate Risk Building	B or C	Moderate	34 to 66	Acceptable legally. Improvement recommended		Not recommended. Acceptable only in exceptional circumstances
High Risk Building	D or E	High	33 or lower	Unacceptable (Improvement	Unacceptable	Unacceptable

- **Figure 2: NZSEE Risk Classifications Extracted from table 2.2 of the NZSEE 2006 AISPBE Guidelines**

Table 1 below provides an indication of the risk of failure for an existing building with a given percentage NBS, relative to the risk of failure for a new building that has been designed to meet current Building Code criteria (the annual probability of exceedance specified by current earthquake design standards for a building of 'normal' importance is 1/500, or 0.2% in the next year, which is equivalent to 10% probability of exceedance in the next 50 years.

- **Table 1: %NBS compared to relative risk of failure**

Percentage of New Building Standard (%NBS)	Relative Risk (Approximate)
>100	<1 time
80-100	1-2 times
67-80	2-5 times
33-67	5-10 times
20-33	10-25 times
<20	>25 times

5. Building Details

5.1. Building description

The building is located at the BMX track in Bexley Park near 194 Bexley Road. There are three buildings on this site, but only the underground bunker is within the scope of this assessment. The building has one storey that doesn't currently appear to be in use. It was assumed to be utilised as a shelter for the BMX track. The building appears to be constructed from a steel shipping container, approximately 2.5m wide by 2.6m high by 6.1m long, based on current typical New Zealand shipping container dimensions. It is retaining soil up to its full height on three sides, with the entrance created by forming two timber retaining walls, one on each side. The building is assumed to have no foundations, except for the steel base of the container. A 300mm deep concrete slab exists on top of the roof of the bunker, which is incorporated into the BMX track. The slab extends either side of the container width, resting on the retained soil. It is assumed the building was designed and constructed in the 1980's.

Our evaluation was based on the external visual inspection carried out on 18 July 2012. Internal inspection was not able to be carried out due to the perceived instability of the southern timber retaining wall at the entrance to the building. Drawings were not available to verify the foundation and retaining systems and the date of construction.

5.2. Gravity Load Resisting system

It appears that the gravity loads are taken by the walls of the shipping container, with direct transfer into the ground below.

5.3. Seismic Load Resisting system

Lateral loads acting along and across the building appear to be resisted by the walls of the shipping container acting as a diaphragm to transfer shear.

Note that for this building the 'along direction' has been taken as east-west and the 'across direction' has been taken as north-south.

5.4. Building Damage

SKM undertook an inspection on 18 July 2012. The following areas of damage were observed during the time of inspection:

1) Southern wall of the shipping container appears to have buckled inwards.
2) Eastern entrance panel appears to have buckled inwards. However, this could also have been caused by impact damage unrelated to the earthquakes.

3) Southern timber retaining wall forming eastern entrance has no fixed connections and some timber elements are displaced. It should be noted that the retaining wall could have undergone damage before the earthquakes, with the damage being exacerbated by the earthquakes.

Photos of the above damage can be found in Appendix 1 – Photos.

6. Quantitative Assessment

6.1. Available Information

Following our inspection on 18 July 2012, SKM carried out a seismic review on the structure. This review was undertaken using the available information which was as follows:

- SKM site measurements and external visual inspection findings of the building. Please note no internal inspection or intrusive investigations were undertaken.
- There were no drawings available to carry out our review.

6.2. Survey

No visual evidence of settlement was noted at this site. Therefore we do not recommend that any survey be undertaken at this stage of the assessment.

6.3. Assumptions

The assumptions and design criteria made in undertaking the assessment include:

- The building was built according to good practice at the time.
- The soil on site is class D as described in AS/NZS1170.5:2004, Clause 3.1.3, Soft Soil. This is a conservative assumption based on our findings from the Desktop study. The ultimate bearing capacity on site is 250kPa. It is possible that a site specific study could result in the bearing capacity being revised. Liquefaction needs to be accounted for in the foundation design as the liquefaction risk is moderate to severe at this site.
- Standard design assumptions for typical office and factory buildings as described in AS/NZS1170.0:2002:
  - 50 year design life, which is the default NZ Building Code design life.
  - Structure importance level 1. This level of importance is described as ‘low’ with small or moderate consequence for loss of human life, or considerable economic, social or environmental consequence of failure.
- The building has a short period less than 0.4 seconds.
- Site hazard factor, Z = 0.3, NZBC, Clause B1 Structure, Amendment 11 effective from 1 August 2011
- The following ductility criteria used in the building:

- **Table 2: Assumed Building Ductility**

Building	Ductility of Building in Current State	Ductility of Building in Strengthened State
Building 1	1.25	1.25

The assumed ductility of the building in its current state is conservatively assumed to be 1.25 as it is located below ground, which would affect its behaviour when loaded.

- The following material properties were used in the analyses:

- **Table 3: Material Properties**

Material	Nominal Strength	Structural Performance
Structural Steel	f_y = 250MPa	S_p = 1.0
Concrete	f_c' = 25MPa	S_p = 1.0
Timber - Unknown	f_b = 10MPa & f_c = 15MPa	S_p = 1.0

The quantitative assessment is a post construction evaluation. Since it is not a full design and construction monitoring, it has the following limitations:

- It is not likely to pick up on any concealed construction errors (if they exist)
- Other possible issues that could affect the performance of the building such as corrosion and modifications to the structure will not be identified unless they are visible and have been specifically mentioned in this report.
- The detailed engineering evaluation deals only with the structural aspects of the structure. Other aspects such as building services are not covered.

6.4. The Detailed Engineering Evaluation (DEE) process

The DEE process is a procedure written by the Department of Building and Housing's Engineering Advisory Group and grades buildings according to their likely performance in a seismic event. The procedure is not yet recognised by the NZ Building Code but is widely used and recognised by the Christchurch City Council as the preferred method for preliminary seismic investigations of buildings[3].

The procedure of the DEE is as follows:

1) Qualitative assessment procedure

---

[3] http://resources.ccc.govt.nz/files/EarthquakeProneDangerousAndInsanitaryBuildingsPolicy2010.pdf

   a. Determine the building's status following any rapid assessment that have been done
   b. Review any existing documentation that is available. This will give the engineer an understanding of how the building is expected to behave. If no documentation is available, site measurements may be required
   c. Review the foundations and any geotechnical information available. This will include determining the zoning of the land and the likely soil behaviour, a site investigation may be required
   d. Investigate possible Critical Structural Weaknesses (CSW) or collapse hazards
   e. Assess the original and post earthquake strength of the building (this assessment is subsequently superseded by the quantitative assessment and hence has not been carried out in this report)

2) Quantitative procedure
   a. Carry out a geotechnical investigation if required by the qualitative assessment
   b. Analyse the building according to current building codes and standards. Analysis accounts for damage to the building.

The DEE assessment ranks buildings according to how well they are likely to perform relative to a new building designed to current earthquake standards, as shown in Table 4. The building rank is indicated by the percent of the required New Building Standard (%NBS) strength that the building is considered to have. Earthquake prone buildings are defined as having less than 33% NBS strength which correlates to an increased risk of approximately 20 times that of 100% NBS[4]. Buildings that are identified to be earthquake prone are required by law to be strengthened within 30 years of the owner being notified that the building is potentially earthquake prone[5]. This timeframe is likely to be adjusted by CERA and Table 6 below contains the likely new recommendations.

[4] NZSEE 2006, *Assessment and Improvement of the Structural Performance of Buildings in Earthquakes,* p 2-2

[5] http://resources.ccc.govt.nz/files/EarthquakeProneDangerousAndInsanitaryBuildingsPolicy2010.pdf

- **Table 4: DEE Risk classifications**

Description	Grade	Risk	%NBS	Structural performance
Low risk building	A+	Low	> 100	Acceptable. Improvement may be desirable.
	A		100 to 80	
	B		80 to 67	
Moderate risk building	C	Moderate	67 to 33	Acceptable legally. Improvement recommended.
High risk building	D	High	33 to 20	Unacceptable. Improvement required.
	E		< 20	

The DEE method rates buildings based on the plans (if available) and other information known about the building and some more subjective parameters associated with how the building is detailed and so it is possible that %NBS derived from different engineers may differ.

This assessment describes only the likely seismic Ultimate Limit State (ULS) performance of the building. The ULS is the level of earthquake that can be resisted by the building without catastrophic failure. The DEE does also consider Serviceability Limit State (SLS) performance of the building and or the level of earthquake that would start to cause damage to the building but this result is secondary to the ULS performance.

The NZ Building Code describes that the relevant codes for NBS are primarily:

- AS/NZS 1170 parts 0, 1 and 5 Structural Design Actions
- NZS 3101:2006 Concrete Structures Standard
- NZS 3404:1997 Steel Structures Standard
- NZS 2606:1993 Timber Structures Standard
- NZS 4230:1990 Design of Reinforced Concrete Masonry Structures

6.5. Critical Structural Weaknesses

No critical structural weaknesses have been identified in this building. However it should be noted that the instability of the southern timber retaining wall at the entrance to the structure creates a collapse hazard.

6.6. Analysis Results

The equivalent static force method was used to analyse the seismic capacity of the building. The results of the analysis are reported in the following table as %NBS. The results below are calculated for the building in its damaged state. The building results have been broken down into their seismic resisting elements. As the building has elements that are less than 34%NBS any item with a capacity less than 67%NBS will need to be strengthened so that the overall building capacity is greater than 67%NBS.

(%NBS = the reliable strength / new building standards)

- **Table 5: DEE Results**

Seismic Resisting Element	Action	Seismic Rating %NBS
South retaining wall	Bending	Structurally unstable. Capacity estimated at 10%.
Container walls	Bending	44%
Container walls	Compression	>100%

6.7. Recommendations

The quantitative assessment carried out on the building indicated that the building foundations have a seismic capacity less than 34% of NBS due to the moderate to severe liquefaction risk and is therefore classed as being in the category of ‘High Risk Buildings’. Due to the low importance level and low consequence of failure of the structure, it is not cost-effective to strengthen the foundations to bring it up to the minimum required of 67% NBS.

Two options are recommended, depending on whether a structure is still required on the site to carry out the same or similar function as the current building. The preferred option is that the container is removed, the retaining walls be demolished and the site be filled with compacted backfill. The less-preferred option is that the building be strengthened to achieve life-safety only by strengthening the walls to 67% NBS. This acknowledges that the building may undergo settlement, differential settlement and/or flooding from site ejecta in another seismic event. The southern retaining wall would need to be reinstated with an appropriate design.

We recommend that the following actions are taken:

- Due to the structural instability of the southern timber retaining wall, we strongly recommend that the building should not be occupied until strengthening measures are carried out.

The building needs to be evacuated due to the structural instability of the southern retaining wall and the lack of foundations, which will impact on the seismic capacity of the building. The building occupier should evacuate the building until it is strengthened or propped on the basis of the limiting building capacity summarised above in Table 5. The building occupier should ensure that they are meeting their requirements under the health and safety in employment act.

If it is determined that the building should be repaired there are a number of issues which will need to be investigated and associated documents prepared in order to submit a building consent application. These issues will need to be considered during the initial phase of strengthening works. Listed below are the likely items the council may require to be explored:

- A geotechnical investigation will be required and associated factual and interpretive geotechnical reports prepared – the geotechnical reports will be required to enable completion of the strengthening design.
- A fire report will be required and all necessary upgrades to egress routes, emergency lighting and specified systems will need to be undertaken.
- An emergency lighting design will be required to meet the provisions noted in the fire report.
- A disabled access summary will be required including provision for disabled facilities.
- The site amenities (toilets and the like) will need to be reviewed to ensure that there are sufficient facilities for the expected number of people on site.
- Landscaping will need to be considered although we do not anticipate that any modifications will be required since the footprint area of building on site will not be adjusted and will likely only be required for the new build option.

7. Further Investigation

Due to the structural instability of the southern timber retaining wall at the east entrance to the building, internal inspection was not able to be carried out during the site inspection on 18 June 2012. Once the southern slope has been stabilised, it is recommended that an internal inspection is carried out to confirm building dimensions, including the wall profile, and whether the building has undergone further damage than that mentioned above in Section 5.

8. Conclusion

A quantitative assessment was carried out on the building located at the BMX track in Bexley Park near 194 Bexley Road, Bexley. The building has sustained minor damage to the walls of the shipping container with inwards buckling of the steel. The southern timber retaining wall at the east entrance is structurally unstable as it appears to have no fixed connections between structural members and some elements are displaced.

The building has been assessed to have a seismic capacity as shown in Table 6 below and is therefore potentially earthquake prone. No critical structural weaknesses have been identified, however the southern retaining wall represents a collapse hazard due to its instability.

Table 6: Quantitative assessment summary

Grade	Risk	%NBS	Structural performance
E	High	10%	Likely seismic capacity is unable to be quantified due to lack of foundations and structural instability of southern retaining wall at the building entrance. Demolition or improvement required.

Strengthening is required on the building to bring the seismic capacity up to at a minimum of 67% NBS. Strengthening works required on the foundations of the building will be extensive relative to its low importance level and low consequence of failure and it may be more feasible to remove the shipping container, demolish the retaining walls and fill the site with compacted backfill. Another option is to strengthen the walls of the building to 67% NBS for life safety only. This acknowledges that the building may undergo settlement, differential settlement and /or flooding from site ejecta in another seismic event.

We make the following additional recommendations if the building is to be repaired:

- A full geotechnical investigation will be required prior to lodging a consent for the repairs and any design changes recommended in the geotechnical investigation will need to be incorporated in the detailed strengthening design
- A detailed strengthening design should be undertaken
- A full strengthening and repair specification should be prepared accounting for the damage contained in the damage assessment report and strengthening as confirmed by the detailed design

Due to the structural instability of the southern timber retaining wall, we strongly recommend that the building should not be occupied until strengthening measures are carried out.

It is recommended that:

a) The building is unsafe to occupy on the basis of the instability of the southern retaining wall.
b) We consider that barriers around the building are necessary due to the collapse hazard represented by the south retaining wall.

9. Limitation Statement

This report has been prepared on behalf of, and for the exclusive use of, SKM's client, and is subject to, and issued in accordance with, the provisions of the contract between SKM and the Client. It is not possible to make a proper assessment of this report without a clear understanding of the terms of engagement under which it has been prepared, including the scope of the instructions and directions given to, and the assumptions made by, SKM. The report may not address issues which would need to be considered for another party if that party's particular circumstances, requirements and experience were known and, further, may make assumptions about matters of which a third party is not aware. No responsibility or liability to any third party is accepted for any loss or damage whatsoever arising out of the use of or reliance on this report by any third party.

Without limiting any of the above, in the event of any liability, SKM's liability, whether under the law of contract, tort, statute, equity or otherwise, is limited in as set out in the terms of the engagement with the Client.

It is not within SKM's scope or responsibility to identify the presence of asbestos, nor the responsibility of SKM to identify possible sources of asbestos. Therefore for any property pre-dating 1989, the presence of asbestos materials should be considered when costing remedial measures or possible demolition.

There is a risk of further movement and increased cracking due to subsequent aftershocks or settlement.

Should there be any further significant earthquake event, of a magnitude 5 or greater, it will be necessary to conduct a follow-up investigation, as the observations, conclusions and recommendations of this report may no longer apply Earthquake of a lower magnitude may also cause damage, and SKM should be advised immediately if further damage is visible or suspected.

10. Appendix 1 – Photos

	
Photo 1: East elevation showing building entrance and timber retaining walls.	Photo 2: Northeast elevation showing building entrance and timber retaining walls.
	
Photo 3: East elevation showing building entrance and timber retaining walls.	Photo 4: Northeast elevation showing 300mm deep concrete slab over building, incorporated into BMX track.

	
Photo 5: Entrance to shipping container, showing inwards buckling of southern wall.	Photo 6: Entrance to shipping container, showing inwards buckling of southern wall.
	
Photo 7: Retained soil to the north of the building, with 300mm deep concrete slab above.	Photo 8: Southern timber retaining wall and east entrance to building, with cracked concrete slab above.

	
Photo 9: Southern timber retaining wall and east entrance to building, with cracked concrete slab above. Loss of retained material can be seen.	Photo 10: Southern timber retaining wall and east entrance to building, with cracked concrete slab above. Loss of retained material can be seen.
	
Photo 11: Southern view of east entrance with 300mm deep concrete slab extending either side of the entrance.	Photo 12: 300mm deep concrete slab over east entrance.

	
Photo 13: 300mm deep concrete slab over southern corner of east entrance. The slab slopes downwards to form a ramp for the BMX track.	Photo 14: West view above east entrance.

11. Appendix 2 – CERA Standardised Report Form

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Bexley Park - Underground Bunker BMX Area	Reviewer:	Nick Calvert
	Unit / No: 194 / Street: Bexley Road, Bexley	CPEng No:	242062
Building Address:	194 Bexley Road, Bexley	Company:	SKM
Legal Description:		Company project number:	ZB01276.169
		Company phone number:	09 928 5500
	Degrees / Min / Sec		
GPS south:		Date of submission:	4-Mar
GPS east:		Inspection Date:	18/06/2012
		Revision:	B
Building Unique Identifier (CCC):		Is there a full report with this summary?	yes

Site

Site slope:	flat	Max retaining height (m):	2.1
Soil type:		Soil Profile (if available):	
Site Class (to NZS1170.5):	D		
Proximity to waterway (m, if <100m):		If Ground improvement on site, describe:	
Proximity to clifftop (m, if < 100m):			
Proximity to cliff base (m,if <100m):		Approx site elevation (m):	

Building

No. of storeys above ground:	1	single storey = 1	Ground floor elevation (Absolute) (m):	2.10
Ground floor split?	no		Ground floor elevation above ground (m):	2.10
Storeys below ground				
Foundation type:	other (describe)		if Foundation type is other, describe:	Assumed base of shipping container resting on soil.
Building height (m):	2.10		height from ground to level of uppermost seismic mass (for IEP only) (m):	2.1
Floor footprint area (approx):	25			
Age of Building (years):	30		Date of design:	1976-1992
Strengthening present?	no		If so, when (year)?	
			And what load level (%g)?	
Use (ground floor):	recreational		Brief strengthening description:	
Use (upper floors):	recreational			
Use notes (if required):	Roof incorporated into BMX track			
Importance level (to NZS1170.5):	IL1			

Gravity Structure

Gravity System:	frame system		
Roof:	steel framed	rafter type, purlin type and cladding	Stiffened corners of shipping container forming a frame
Floors:	steel deck	type	Base of shipping container
Beams:	none	overall depth x width (mm x mm)	None
Columns:	none	typical dimensions (mm x mm)	None
Walls:	load bearing profiled metal		0

Lateral load resisting structure

Lateral system along:	steel frame with infill	**Note: Define along and across in detailed report!**	ote typical frame sizes and bay length (m)	6.1
Ductility assumed, μ:	1.25			
Period along:	0.10	##### enter height above at H31	estimate or calculation?	estimated
Total deflection (ULS) (mm):	10		estimate or calculation?	estimated
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	estimated
Lateral system across:	steel frame with infill		note typical frame sizes and bay length (m)	2.5
Ductility assumed, μ:	1.25			
Period across:	0.10	##### enter height above at H31	estimate or calculation?	estimated
Total deflection (ULS) (mm):	10		estimate or calculation?	estimated
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	estimated

Separations:

north (mm):		leave blank if not relevant
east (mm):		
south (mm):		
west (mm):		

Non-structural elements

Stairs:			
Wall cladding:	exposed structure	describe	Exposed walls of metal shipping container
Roof Cladding:			
Glazing:			
Ceilings:			
Services(list):	Unknown		

Available documentation

Architectural	none	original designer name/date	
Structural	none	original designer name/date	
Mechanical	none	original designer name/date	
Electrical	none	original designer name/date	
Geotech report	partial	original designer name/date	

Damage

Site:
(refer DEE Table 4-2)

Site performance:		Describe damage:	Southern retaining wall at entrance no longer has secure fixings and soil has been displaced behind the wall, lowering the ground level directly above and causing cracking in concrete slab.
Settlement:	none observed	notes (if applicable):	
Differential settlement:	none observed	notes (if applicable):	
Liquefaction:	none apparent	notes (if applicable):	
Lateral Spread:	none apparent	notes (if applicable):	
Differential lateral spread:	none apparent	notes (if applicable):	
Ground cracks:	none apparent	notes (if applicable):	
Damage to area:	none apparent	notes (if applicable):	

Building:

	Current Placard Status:	red		
Along	Damage ratio:	78%	Describe how damage ratio arrived at:	Buckling of steel container wall diminishes its capacity. Failure of retaining wall severely reduces capacity.
	Describe (summary):			
Across	Damage ratio:	78%		
	Describe (summary):	Buckling inwards of container wall and instability introduced to southern timber retaining wall.		
Diaphragms	Damage?:	yes	Describe:	Container wall has buckled.
CSWs:	Damage?:	no	Describe:	
Pounding:	Damage?:	no	Describe:	
Non-structural:	Damage?:	no	Describe:	

$$Damage\_Ratio = \frac{(\%NBS(before) - \%NBS(after))}{\%NBS(before)}$$

Recommendations

	Level of repair/strengthening required:	demolition	Describe:	Strengthening could be carried out if required, but demolition is strongly recommended.
	Building Consent required:	yes	Describe:	
	Interim occupancy recommendations:	do not occupy	Describe:	Southern timber retaining wall is structurally unstable and a collapse hazard.
Along	Assessed %NBS before:	46%	%NBS from quantitative assessment	
	Assessed %NBS after:	10%	If IEP not used, please detail assessment methodology:	Quantitative Assessment carried out according to NZSEE guidelines (refer to SKM report).
Across	Assessed %NBS before:	46%	%NBS from quantitative assessment	
	Assessed %NBS after:	10%		