BEFORE THE INDEPENDENT HEARINGS PANEL

UNDER	the Resource Management Act 1991	
IN THE MATTER	of proposed Plan Change 14: Housing and Business Choice to the Christchurch District Plan	
AND		
IN THE MATTER	of Cambridge 137 Limited (Submitter 1092)	

STATEMENT OF EVIDENCE OF BRETT ANDREW GILMORE ON BEHALF OF CAMBRIDGE 137 LIMITED

HEARING TOPIC: QUALIFYING MATTER: HERITAGE (HERITAGE SITES)

20 September 2023

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WYNN WILLIAMS

Introduction

- 1 My full name is Brett Andrew Gilmore.
- I am the Joint Managing Director and a Senior Structural Engineer with
 Quoin Structural Consultants (Quoin), and formerly known as Structex
 Metro Ltd (Structex). I have held this position since 2006.
- 3 I received a Bachelor of Engineering (Civil) (Hons) in 1989. I am a member of Engineering New Zealand (ENZ); and am a Chartered Professional Engineer (Reg #139988).
- 4 My relevant experience includes:
 - I have over 30 years' experience in the structural engineering design industry, both in New Zealand and overseas. This includes:
 - (i) Holmes Consulting Group, Christchurch (1992-1999 and 2003-2006).
 - (ii) Thornton Tomasetti Engineers, New York (1999-2003).
 - (iii) Structex Metro Ltd (now Quoin Structural Consultants), Christchurch (2006-present).
 - (b) I have significant expertise in the structural assessment of structural earthquake damaged buildings following the 2010-2011 Canterbury Earthquake Sequence (CES) and developing scopes of repairs for these buildings.
- 5 I am familiar with the site at 137 Cambridge Terrace (Site). I first became involved with the Harley Chambers building soon after the 4 September 2010 Darfield earthquake. Overall, I have completed approximately 22 inspections of the building, which are noted in paragraph 28 as part of summarising my general involvement with the building. The most recent site visit and inspection I have undertaken was on 13 June 2023.
- 6 I confirm that I have read and am familiar with the Code of Conduct for Expert Witnesses contained in the Environment Court Practice Note 2023. I have complied with the Code of Conduct in preparing this evidence and I agree to comply with it while giving any oral evidence during this hearing. Except where I state that I am relying on the evidence of another person, my evidence is within my area of expertise.

I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

Scope of Evidence

- 7 I have prepared this evidence on behalf of Cambridge 137 Limited (submitter number 1092) seeking the removal of the Harley Chambers building from Appendix 9.3.7.2 of the District Plan and have been engaged to provide engineering evidence in respect of the Harley Chambers building on the Site. This evidence is given in relation to Hearing Topic – Qualifying Matter – Heritage – Heritage Sites. I have also given evidence on behalf of Submitter 874 in relation to the Daresbury Homestead on this same topic.
- 8 Specifically, my evidence addresses:
 - (a) My involvement with the Harley Chambers building and a summary of the structural components of the building
 - (b) The current structural damage to the building and associated risks;
 - (c) Structural assessment of the building;
 - (d) Previous work undertaken on the building;
 - (e) Repairs required to restore the building to 34%, 67% and 100% of the new building standards (NBS);
 - (f) A response to the evidence for Christchurch City Council in relation to the submission by Cambridge 137 Limited seeking to delist 137 Cambridge Street (Harley Chambers) from Appendix 9.3.7.2 'Schedule of Significant Historic Heritage'.
- 9 In preparing my evidence, I have reviewed and/or referred to the following documents:
 - (a) Submission by Cambridge 137 Limited (Submitter #1092) seeking the delisting of the Harley Chambers building;
 - (b) Quoin Structural Consultants, Structural Report to Accompany Assessment of Environmental Effects and Resource Consent Application, 13 December 2017 (Appendix A to my evidence);
 - (c) Letter to Valour Properties Ltd from Structex Metro Ltd –
 Continuing Concerns Regarding Occupancy, Damage to Building

& Construction of New Adjacent Building, dated 10 October 2013 (**Appendix B** to my evidence);

- (d) Letter to Michael Doig from Quoin Structural Consultants Updated Structural Report for Harley Chambers dated 12 July 2023;¹
- (e) Centraus Structural Consulting, Heritage Structural Restoration Feasibility Report, 14 July 2023;²
- (f) Evidence of David Pearson for the Christchurch City Council dated 11 August 2023. The sections of Mr Pearson's evidence that specifically relate to the structural considerations include paragraphs 62-80;
- (g) Evidence of Stephen Hogg for the Christchurch City Council dated 11 August 2023. The sections of Mr Hogg's evidence that specifically relate to Submission #1092 Harley Chambers includes pages 19-31; and
- (h) The evidence of Mr Gerrard, Mr Doody, Mr Brown, Mr Pomeroy and Mr Bonis on behalf of Cambridge 137 Limited.

Executive summary

- 10 The building has been extensively damaged from the CES.
- 11 The building is repairable, as most buildings are.
- 12 The building has been assessed to have a current earthquake strength of 15% x NBS. It is an earthquake prone building under the Building Act 2004.
- 13 The scope of works required to repair the building back to a minimum earthquake strength level of 34% x NBS is significant.
- 14 The minimum target level for earthquake strengthening is normally considered to be 67% x NBS, as the normal industry standard minimum, if the use and occupancy of the building were to remain unchanged from

¹ A copy is provided as Appendix A to Mr Hogg's evidence dated 11 August 2023.

² A copy is provided as Appendix B to Mr Hogg's evidence dated 11 August 2023.

its previous office/commercial use. The scope of repairs, strengthening works, and costs, are again higher than for 34% x NBS.

- 15 It is noted that if the building were to be considered for a change of occupancy and use as part of the repairs, such as changing from an office use to a hotel use, then the Council would require the building to be strengthened to 100% x NBS, or as close as practically possible to do so. The scope of repairs and strengthening works, and costs, are higher than for 67% x NBS.
- 16 I have been involved with the review and assessment of the building since September 2010. Over this time, it has been hugely difficult, despite the best efforts of the owners (both previously and current), to prevent access into the building from unauthorised parties. A fire occurred recently in a section of the building that resulted in localised weakening of the structure.
- 17 I recommended that temporary propping be installed to the north-east column in December 2016, if the north section of the building were not to be demolished at that time. This followed my review of the building and the added damage I observed following the 2016 Kaikoura earthquake.
- 18 To date no temporary propping has been installed to the north-east column (although I note the current owners have only very recently taken ownership of the building and I understand discussions are ongoing in relation to this). This column may fail under a moderate earthquake and result in partial collapse of this corner of the building.
- 19 Other dangerous areas from a structural perspective of the building include the concrete canopy apron slab that is directly adjacent to the public footpath on the east side of the building, and the unreinforced brick parapets to the rear sides of the building and with some of these directly above and adjacent to the shared right-of-way with the Worcester Chambers building and that acts as a fire egress path for that building.
- 20 In its current condition, the building, as a whole, is not likely to collapse outwards into public spaces due to its proportions and structure, but localised parts such as the north-east column and small debris from the façade could likely fall outwards and cause a hazard to public safety.

- 21 The building continues to degrade over time, with on1 augoing exacerbation of cracks to the exterior façade and east canopy apron slab, plus the effects of foundation settlement at the north-east corner, and the effects of vandalism and a fire from unauthorised parties. Moderate earthquakes will also degrade the building further.
- 22 My recommendation to install a nominal safety barrier between the building and footpath were being acted upon, but it has been impossible for the owners to ensure that it is retained in the correct position (which is on public footpath and therefore not in the owners control) which means it is not serving its intended purpose.
- With my long involvement with the building since the CES, I have observed genuine attempts to retain the building in the best condition possible and develop an option to repair and strengthen the building. This has resulted in both the previous and current owners concluding that it is not economic to repair and strengthen the building back to a minimum earthquake strength of 67% x NBS.
- 24 I agree that the dangerous and vulnerable parts of the building can be temporarily secured to mitigate the safety issues, but these added works will increase the repair costs further beyond what has already been assessed by others to be uneconomic.
- 25 The façade to Harley Chambers could be retained and incorporated into a new building development, but substantial additional works are required to repair, strengthen it to 100% x NBS, temporarily prop the façade, and demolish the building in behind the face.
- 26 Demolition experts have advised the new Owner that a section of the south side façade would need to be deconstructed to achieve suitable access to demolish the building behind the façade.
- 27 In addition to the part demolition of the south façade, the north end of the east side façade that includes the north-east corner column will also need to be deconstructed and rebuilt, plus all of the plaster to the façade will need to be removed and reinstated as part of the repairs and strengthening. The heritage impacts of this are addressed in Mr Brown's evidence.

My involvement with the building and a summary of the building structural components

- 28 My involvement with the building includes the following, where I have been engaged by either the previous or current building owners:
 - (a) One inspection of the building following the 4 September 2010
 Darfield Earthquake to assess whether it was safe to occupy plus advice on interim securing measures for the east side parapet.
 - (b) One inspection in January 2011 to confirm interim securing measures for the unreinforced brick lift shaft above roof level.
 - (c) Three inspections in early March 2011 to assess damage following the 22 February 2011 Lyttelton earthquake.
 - (d) Completion of Detailed Engineering Evaluation Report dated 8 November 2011, including:
 - i. Summary of the earthquake damage;
 - ii. Investigations of the building's construction;
 - iii. Preliminary outline scope of repairs;
 - Assessment of the building's earthquake strength as a percentage of the New Building Standard (% x NBS);
 - Concepts and outline scope of works for strengthening the north section of the building to 33% x NBS, 66% x NBS, and 100% x NBS; and
 - vi. One inspection in August 2011 and supervision of engineering staff to assist with the engineering analyses and calculations for the evaluation.
 - (e) Supervision of safe access of other parties (previous Owner, Loss Adjuster and Insurer's structural engineer, Quantity Surveyor, Services Engineer, Contractors, Heritage) to inspect the building as part of the Insurance Claim during the period 2011-2015. This included two inspections to supervise invasive investigations of the building's construction and seven visits to assist and supervise other parties.
 - (f) In 2015, assisted in agreeing the final scope of the structural repairs for the Insurance Claim with the Insurers' engineer.

- Provision of structural condition and safety assessment of the (g) building following a letter received by the previous Owner from CERA (under the Canterbury Earthquake Recovery Act) dated 27 September 2013 regarding continuing concerns regarding occupancy and safety of the building, and a letter received from Aurecon dated 8 October 2013 that expressed significant concerns about the north wall of the Harley Chambers Building that is located directly adjacent to the new building that is to be constructed at 141 Cambridge Terrace. I inspected the building and provided the assessment in October 2013 (Appendix B to my evidence). I recommended the demolition of the north section of the building at this time as the safest methodology to ensure safety to the new building under construction at 141 Cambridge Terrace and the continued occupancy of the Worcester Chambers building directly adjacent.
- (h) One inspection in December 2016 to assess additional damage to the building following the 14 November 2016 Kaikoura earthquake.
- (i) Following the inspection in (h), provision of letter dated 21 December 2016 to previous Owner recommending the demolition of the building, or if not possible, then temporary works to be undertaken to the north-east column and other vulnerable elements, and providing added controls to prevent unauthorised access into the building. This letter was updated and included as part of the letter to Michael Doig dated 12 July 2023³.
- Provision of Structural Report to Accompany Assessment of Environmental Effects and Resource Consent Application, 13
 December 2017 (Appendix A to my evidence).
- (k) Four inspections of the building in 2017-2018 as part of (j) above and assisting with supervision of other parties (Christchurch City Council, previous Owner, Christchurch Press) to safely inspect the building.
- Provision of letter to Michael Doig dated 12 July 2023³ to provide a current assessment of the building's condition as an update to my

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A copy is provided as Appendix A to Mr Hogg's evidence dated 11 August 2023.

review and letter per (i) above. This followed my most recent inspection of the building on 13 June 2023.

29 A summary of the structural components of the building is included in Section 4.1.2 Structural Systems of the report at **Appendix A** to my evidence.

Current structural damage to the building and associated risks

- 30 Harley Chambers building has suffered earthquake damage and continues to deteriorate over time due to a number of issues that include but may not be limited to:
 - (a) Ingress of water through cracks in the walls.
 - (b) Ingress of water into the basement.
 - (c) Effects of small to moderate earthquakes (e.g. 2016 Kaikoura earthquake) referred to at paragraph 28(h) and 28(i).
 - (d) Ongoing effects of the settlement of the foundations at the northeast corner of the building, resulting in exacerbation of cracks and added flexural and shear stresses in the column and adjacent beams over the height of the building.
 - (e) Differential thermal effects that exacerbate current cracks in the plaster and concrete, as cracks widen/close and extend with changes in temperature.
 - (f) Vandalism from unauthorised parties (e.g. broken windows, damage to interior finishes, a fire).
 - (g) Deposits of excrement from pigeons and cats and the effects of such contamination on the internal finishes.
- 31 The type of degradation I have observed since the main part of CES between September 2010 to December 2012, includes the following, as generally referred to in my letter dated 12 July 2023 attached as Appendix B to Mr Hogg's evidence:
 - (a) Widening of cracks. For example:
 - i. At base of north-east column, with most of the degradation noted between 2012-2016.

- ii. In the foundation wall adjacent to the north-east column, with widening noted between 2012-2016 and further degradation between 2016-2023.
- iii. In the concrete canopy apron slab over the Cambridge Terrace entrance, with widening noted between 2012-2016 and significant added degradation noted between 2016-2023.
- At the base of the parapets that face on to Cambridge Terrace and Worcester Boulevard, with most of the degradation noted between 2012-2016.
- In the exterior plaster façade to Cambridge Terrace and Worcester Boulevard. Widespread additional cracks noted between 2012-2016, and further widening of cracks noted between 2016-2023 in the east façade beneath the northernmost lowest window, adjacent to the north-east column.
- (b) Lengthening of cracks, typically in the exterior plaster.
- New cracks, typically in the exterior plaster façade to Cambridge Terrace and Worcester Boulevard mainly observed between 2012-2016.
- (d) Widening of east side external joint between the north and south sections of the building with most of the widening noted between 2012-2016.
- 32 The current damage, and any associated risks, I have observed to the Harley Chambers building from my inspections, including the two most recent inspections of the damage in 2016 and 2023 are outlined below.

Damage to north-east column

33 Based on the inspections of the building that I have undertaken I have observed significant extension and widening of the horizontal crack near the base of the north-east column, directly adjacent to the footpath on Cambridge Terrace. The crack varies in width from 0.5mm to 2.0mm and is worst on the inside face where it extends across the full northsouth width of the column. The north face of the column is hidden behind a flashing across the gap to the adjacent building. The crack appears to end at the bottom corner of the adjacent window at the south side of the column.

- 34 Horizontal cracks that form between the horizontal reinforcing on the column, are normally considered to be dangerous and could result in a more sudden type of failure of the column under moderate lateral earthquakes.
- 35 If a moderate to large earthquake were to occur in Christchurch (estimate magnitude 6.0 or greater) then this column could fail and cause partial collapse of this corner of the building.
- 36 The building itself will not fail as a whole, but debris, such as small-large sections of spalled concrete, could fall out onto the adjacent footpath. The suspended floors are well reinforced and the perimeter beams tie into the column at each floor level. However, the uncertain nature of earthquakes means that if earthquakes were to occur, I would anticipate that significant additional damage could occur.
- 37 A barricade fence was installed adjacent to this northeast section and is currently in place. However, it is noted that the barricade is located hard up against the building and does not have the recommended one metre minimum gap from the building and 5m away from this corner. It appears that it is not a simple process to ensure that the barricade is maintained at the recommended safe distance from the building because the public footpath is not in the control of the Building Owner. I expect that having the recommended gap between the building and footpath would greatly reduce the width and useability of the public footpath.
- 38 The column and adjacent beams have increased residual flexural and shear stresses over the height of the building due to the settlement, as noted in paragraph 30(d) above, and hence a reduced strength in addition to the effects of the cracking damage.

Joint between the north and south section of the building

- 39 The joint between the north and south sections of the building appears to have widened by approximately 5mm since 2015.
- 40 At the top of the joint at parapet level, facing Cambridge Terrace, it appears that there could be some loose concrete. I cannot conclusively determine the extent of loose concrete without a closer inspection from

the outside over the full height of the joint. This section was cleaned out following my inspection of the parapets (via the roof) in January 2012, but given its location and proximity to the footpath this section should be inspected further.

- 41 I also observed widening of cracks in the front concrete canopy apron over the entry off Cambridge Terrace, which is adjacent to the gap noted above. I do not know exactly how the canopy apron is constructed and so have taken a more cautious assessment.
- 42 The extent of cracking to the canopy apron appears to be significantly worse than when inspected in December 2016, which has possibly been caused by ingress of water and the effects of thermal variations over time on the previous cracks. The cracks occur at the mitred corners, so the apron slab may be susceptible to severe damage and possible collapse in a moderate earthquake, depending on the condition of the reinforcing.
- 43 This means that if any part of the canopy apron were to break, or collapse under a moderate earthquake, then the barricade may not prevent serious injury to the passing public.

Cracks to the parapet

In my 2016 inspection, I observed the cracks at the base of the parapet that appear to have become more visible since my inspection on 29 June 2015. The parapets that face onto Cambridge Terrace and Worcester Boulevard comprise of reinforced concrete. Without closer inspection, it is difficult to assess what amount of exacerbation has occurred since 2016. However, in my opinion they are safe.

Front façade to Cambridge Terrace and Worcester Boulevard

- In my 2016 inspection, I observed a number of new cracks in the front façade to Cambridge Terrace and Worcester Boulevard (plaster over concrete structure) since my previous assessment on 29 June 2015. It is also possible these are older cracks that have widened and/or extended. Without closer inspection and detailed mapping of the cracks, it is difficult to assess what amount of exacerbation has occurred since 2016.
- 46 Since my inspection in 2015, the cracks have worsened such that ongoing degradation from wind and rain would likely cause spalling of the plaster/concrete that might comprise of small pebble sized sections

of plaster. I note that the cracks are directly adjacent to the footpath, and are worst along Cambridge Terrace.

47 In addition, the very wide cracks in the east façade beneath the northern-most lowest window, adjacent to the north-east column noted above, appear to have widened slightly since 2016. This suggests possible ongoing settlement of the corner column. I also note that the basement is located near this same corner of the building and is currently full of water.

Damage as a result of a fire in the south-west corner of the north section

- 48 A fire occurred in the south-west corner of the north section of the building at ground level. The ceiling has been burnt out and it appears that the soffit of the concrete floor above was exposed to the fire.
- 49 In addition, extensive spalling occurred to the plaster finishes of the internal breeze block wall. This has likely resulted in a reduction in loadbearing capacity of the floor in this localised area.

Other additional degradation to the structure

- 50 Due the basement being full of stagnant water for long periods of time, as well as the settlement that has occurred and appears to be ongoing, there is likely to be added degradation to the building. This includes, but may not be limited to:
 - (a) More extensive contamination of the concrete to the basement walls and base slab.
 - (b) Added degradation of the reinforcing, typically at the crack locations.
 - (c) Added stresses in the corner column and adjacent beams, over the height of the building, as caused by the settlement. Such cumulative added stresses reduce the residual strength of the affected column and adjacent beams.

Structural assessment of the building

51 I completed a structural assessment of the building as part of the Insurance Claim process for the building and in support of a previous resource consent application to demolish Harley Chambers (along with partially demolishing Worcester Chambers) and building a new hotel. That proposal did not proceed.

- 53 The structural assessment of the building (prepared for the previous resource consent application in 2016) assessed the building to be:
 - (a) For the north section of the building:
 - (i) 15% to 40% of the NBS in the building's damaged state; and
 - (ii) 25% to 55% of the NBS in the building's undamaged state.
 - (b) For the south section of the building:
 - (i) 34% of the NBS in the buildings damaged state; and
 - (ii) 37% of the NBS in its undamaged state.
- 54 From my inspection in 2016, the condition of the north-east corner column has reduced since the previous structural assessment. Based on my inspection in 2016 and the assessed current condition, the north section of the building is less than 15% of the NBS.
- 55 Since the structural assessment was completed in 2016, the building in its current condition has degraded further and will continue to do so. The building as a whole is earthquake prone (as defined under the Building Act 2004) and has an assessed earthquake strength of 15% NBS. The earthquake prone notice requires works to be completed (or the building demolished) by 14 June 2025. It would be possible for work to comprise of propping (and potentially other measures) to secure the building rather than necessarily completing repairs.
- 56 Despite being earthquake prone, in my opinion the building is not considered to be "dangerous" in its current condition as of 20 September 2023, and on the assumption that the building is not occupied. This is because the definition in section 121 of the Building Act 2004 specifically excludes earthquake events:

121 Meaning of dangerous building

(1) A building is dangerous for the purposes of this Act if,-

(a) in the ordinary course of events (excluding the occurrence of an earthquake), the building is likely to cause—

(i) injury or death (whether by collapse or otherwise) to any persons in it or to persons on other property; or

- (ii) damage to other property; or
- (b) in the event of fire, injury or death to any persons in the building or to persons on other property is likely.
- 57 The building's concrete floors and frames mean that the building does not need to rely on its bricks to withstand fire, and would therefore likely to be able to withstand this load case.

Previous work undertaken on the building

- 58 A steel bracket was installed to the inside face of the parapet to Cambridge Terrace, at the location of the joint between the north and south sections of the building. This was installed in September 2010, soon after the Darfield earthquake.
- 59 Timber framing was installed to the exterior face of the unreinforced brick lift shaft, above roof level. This was installed in January 2011.
- 60 The brick lift shaft referred to above was removed down to roof level in March 2011, following the 22 February 2011 earthquake.
- 61 I understand that windows were removed and replaced with plywood some time between 2017-2022 as a measure by the previous Owner to control vandalism and unauthorised access into the building.
- 62 A new building on the north side of Harley Chambers was constructed in 2013-2015. Due to this new building, the north parapet and brick infill to the north wall was required to be removed to ensure safety on the adjacent site.
- 63 These emergency works were approved by the Canterbury Earthquake Recovery Authority (CERA) and the works were completed in 2013.
- 64 At the times these works were occurring I recommended that the north section of the building be deconstructed due to the poor structural condition of the building and the very low structure assessment against the NBS. However, the deconstruction did not proceed.
- 65 Various areas of floor, wall, and ceiling finishes were removed to facilitate the investigations of the structure between 2011-2015.

Reasons to deconstruct Harley Chambers

- 66 Whilst I accept that from an engineering perspective it would be possible to repair Harley Chambers, I maintain the opinion I provided in my previous assessment and correspondence to the then building owners that the Harley Chambers building, as a whole, should be deconstructed for the following reasons:
 - (a) If the north-east corner of the building is not to be temporarily propped then it could partially collapse in its current condition under moderate earthquake shaking.
 - (b) The concrete canopy apron directly adjacent to the east side footpath is significantly cracked, and if not propped, could partially collapse under moderate earthquake shaking.
 - (c) In the long term, without substantial engineering works, the building will continue to degrade. This is based on a number of options being assessed my myself and other independent professional to strengthen, repair and refurbish the building.
 - (d) It was evident during my inspection in 2016 that the building was being occupied by unauthorised people. This is a concern given the structural conditions of the building, and also that the internal environment is a health hazard.
 - (e) Other risks in the building include falling debris (ceilings, plaster, damaged breeze blocks), brick parapets to the rear sides of the building, asbestos in some materials, and the basement remains part filled with water. I note that asbestos and mould reports have been recently obtained by the new Building owners confirming the presence of both asbestos and toxic moulds (copies of which are attached to the evidence of Mr Lyttle and Mr Doig).
 - (f) Since 2016, further unauthorised persons have caused a fire to the interior of the building resulting in some weakening of the structure. Any further occurrences such as this could result in more severe damage to the building and injury to people.
 - (g) The building should not be entered without full personal protective equipment, and that is enforced by the current owners.

- (h) The poor condition of the brick parapets to the rear sides of the building mean that there is a safety risk to the fire egress path of the adjacent building when the adjacent building on Worcester Boulevard is occupied. In addition, there is a risk of damage to this adjacent property due to the current poor condition of Harley Chambers and associated risks.
- (i) It is evident that the heritage features of the façade are now extensively damaged. This follows the apparent ongoing degradation of the building exterior as ongoing differential thermal effects and weathering appear to degrade the exterior plaster/concrete at the crack and joint locations.
- 67 In the light of the damage to the building, any further detailed assessment of the external facades directly adjacent to the footpath to survey the extent of any areas of loose plaster and/or debris is considered to be commercially wasteful.
- 68 Overall, it is my opinion that the Harley Chambers building should be deconstructed in order to mitigate the risk the building poses to the public.

Repairs required to restore the building to 34%, 67% and 100% of NBS

- 69 The scope of structural repairs recommended to restore the building to 34%, 67%, and 100% x NBS are summarised in the Quoin Structural Consultants, Structural Report to Accompany Assessment of Environmental Effects and Resource Consent Application, 13 December 2017 (**Appendix A** to my evidence). A brief summary is set out as follows:
- 70 The earthquake strengthening target level of 34% x NBS is the minimum statutory target to allow the building to be occupied. However, such a low target may mean further strengthening work is required in the future if there are changes in the New Zealand Building Code and the Building Act 2004.
- 71 The earthquake strengthening target level of 67% x NBS is the normal and generally accepted industry standard minimum, if the use and occupancy of the building were to remain unchanged from its previous office/commercial use. As the evidence of both Mr Doody and Mr Gerrad addresses, this allows the building to be more easily insured, tenanted

and useable, and that is the normal minimum required by banks when financing is required when buying/selling a building.

- 72 It is noted that if the building were to be considered for a change of occupancy and use as part of the repairs, such as changing from an office use to a hotel use, then the Council would require the building to be strengthened to 100% x NBS, or as close as practically possible to do so.
- 73 As noted below, each of the repair methodologies to achieve a targeted NBS results in substantial removal and replacement of original building fabric.

Repairs to 34% x NBS

- 74 Remove all unreinforced masonry Bell block internal partition infill walls and reinstate with 140mm solid filled reinforced masonry block. This requires installation of new concrete ribs into the existing suspended concrete waffled slab floor system.
- 75 Remove all double brick walls and reinstate with 240mm solid filled reinforced masonry block. Reinstate plaster as required.
- 76 Deconstruct remaining lift shaft walls down to foundation level and reconstruct, including new concrete roof slab.
- 77 Repair junction between the north and south building sections. Break out part sections of the main structural floors, beams and parapets, and reinstate with new tie connections with epoxied reinforcing.
- 78 Reconstruct the basement walls and slab with new tanking system, including temporary propping and support works.
- 79 Repair to concrete wall at north wall of lobby. Reconstruct as part of the basement reconstruction.
- 80 Repair concrete ground floor slab over north end of basement: Reconstruct as part of the basement reconstruction works.
- 81 Repair expansion joint between Harley Chambers and adjacent north building at 141 Cambridge Terrace
- 82 Re-level ground floor and foundations across the building footprint.
 - (a) For the north section: Underpin and jack foundations using steel screw piles to approximately 3.5m depth below ground level. Note

that this excludes area of basement. Interior piles supporting timber floor only and strip footings to Bell Block walls to be reconstructed.

- (b) For the south section: Underpin and jack foundations using steel screw piles. Lesser number of jacking piles required than north section. Interior piles supporting timber floor only to be reconstructed.
- 83 Repair cracks in concrete beams, columns, floors and walls.
- 84 Reconstruct columns at north-east corner and next adjacent column.
- 85 Provide all temporary propping as required to undertake the repairs.
- 86 Remove all wall and ceiling linings and reinstate as new.
- 87 Cracks in exterior plaster: Remove damaged sections as a minimum and reinstate. May require repairs of cracks in concrete substrate, and may require removal of all of the plaster to provide for a more practical repair method.

Repairs to 67% x NBS

- 88 The following repairs and strengthening works are additional to the repairs outlined to repair the building to 34% x NBS.
- 89 Provide new 300mm thick reinforced concrete shear walls at locations shown on the concept drawings.
- 90 Provide new 400mm thick insitu concrete frame columns and beams to east wall elevation.
- 91 Reconstruct lift core concrete walls as new, including lift pit.
- 92 Provide new foundations for the above. Allow for 800mm deep, typical.
- 93 Provide enhanced floor diaphragm ties (reinforcing epoxied into chases in floor slab and/or carbon fibre reinforced polymer strips (CFRP)).
- 94 Remove all hollow masonry Bell block partition walls and replace with lightweight non-structural partitions.
- 95 Add new 150mm and thick reinforced concrete skin walls to South section of the building.

- 96 Add new 250mm and thick reinforced concrete shear walls to South section of the building.
- 97 Cut back existing concrete shear walls at two locations in the south section to improve distribution of seismic loads between wall elements.
- 98 All of the perimeter columns to the south and north sections of the building are to be strengthened using Sika CarboDur strips. This will require all of the exterior plaster to be removed to the exterior façades.
- 99 Provide deeper foundations beneath three of the four proposed new shear walls, plus add 4 piles.
- 100 Strengthen the floor diaphragm with chased in reinforcing bars or CarboDur strips.

Repairs to 100% x NBS

- 101 The following repairs and strengthening works are additional to the repairs outlined to repair the building to 67% x NBS.
- 102 Provide similar but deeper foundations, increased from 800mm deep to 1000mm deep.
- 103 Increase thickness of skin walls from 150mm to 200mm thick and increase reinforcing in these skins.
- 104 Increase extent of supplementary reinforcing bars of CarboDur strips for the floor diaphragm strengthening.

Façade retention option

- 105 The façade to Harley Chambers could with substantial engineering works be retained and incorporated into a new building development.
- 106 The scope of works and proposed methodology to retain the existing façade to Cambridge Terrace and Worcester Boulevard are summarised in the Quoin Structural Consultants, Structural Report to Accompany Assessment of Environmental Effects and Resource Consent Application, 13 December 2017 (**Appendix A** to my evidence) at section 4.6.
- 107 There are likely to be substantial additional works and cost to achieve this and the proportions of the façade would compromise the architectural design and functionality of any new building behind the façade.

- 108 The retention of the façade will require the installation of temporary steel bracing frames, underpinning and relevelling of parts of the foundations, and completion of the earthquake repairs and strengthening of the façade to 100% x NBS as would be required for integrating the façade into a new building.
- 109 The temporary steel bracing frames would likely be located on the inside of the building, rather than on the outside where they would provide significant disruption to the footpaths and roads to Cambridge Terrace and Worcester Boulevard.
- 110 The methodology developed in 2017 assumed part demolition of the north end of the Worcester Chambers building to gain adequate access of suitable sized machinery and equipment to deconstruct the sections of the Harley Chambers building behind the facade. This was possible because the previous owner also owned Worcester Chambers, but this is not possible now with the current ownership of the buildings.
- 111 Subject to review by demolition experts, it is unlikely that suitably sized demolition machinery and equipment can gain access via the narrow right-of-way between the Worcester Chambers and Harley Chambers buildings at the south-west corner of the site, and it does not appear to be feasible to crane such machinery and equipment over the top of the building and into the small space between the north and south sections of the building. Therefore, a section of the façade would likely need to be deconstructed to achieve such suitable access. I understand that demolition experts have advised the new owner that access off Cambridge Terrace was not possible as it is a critical road corridor and that it was not possible to fully close this road as would be required if first stage demolition was to commence here. The demolition experts advised that demolition of a south section of the building and façade adjacent to Worcester Boulevard would allow a more simple road closure and enable a staging area for the demolition of the rest of the building behind the façade.

Evidence for the Christchurch City Council

112 I have read the structural related reports that includes evidence from Mr Pearson of DPA Architects and Mr Hogg of Aurecon for the Christchurch City Council as it relates to structural engineering matters falling within my area of expertise.

Statement of evidence of Mr Pearson:

- 113 The parts of Mr Pearson's evidence that I wish to clarify or comment on are included below in *italics,* along with my comments. The sections of Mr Pearson's evidence that specifically relate to the structural considerations include paragraphs 62-80.
- 114 Paragraph 65

Further correspondence was received from CERA dated 21 November 2013, the purpose of which was to advise Lee Pee Ltd of the fact that CERA considered the building to be dangerous in terms of the CERA Act and that it would need to be partially demolished. The work that was required was indicated in an appendix to the letter and appears to have been limited to the removal of a series of brick infill panels on the north elevation. It is believed that this work was carried out. The letter from CERA also questioned whether the northeast parapet might need to be demolished if no reinforcement was found. It is assumed there was found to be no need to undertake this particular piece of work. Structex ventured the opinion that the north building might be uneconomic to repair and went on to recommend that the North building be deconstructed as soon as possible. No basis was provided for this comment.

As I have addressed above, the work undertaken to only demolish the north parapet was as directed by CERA. Also at this time in November 2013, I was assisting in summarising the scope of the structural repairs as part of the Insurance Claim process and provided the relevant structural information to Aecom Quantity Surveyors for them to estimate the costs to the repair the building back to a minimum strength of 34% x NBS. With Aecom's initial estimate at this time, the previous owner advised to me that it was unlikely that the building would be economic to repair.

115 Paragraph 73

There are, however, no figures quoted in the report to back up the claim that to repair the building would be uneconomic.

My opinion of the economics of repairing the building is based on:

- (a) My knowledge of the costs estimated by Aecom to repair the building as part of the Insurance Claim. I note that Mr Pomeroy has updated these costs as addressed in his evidence.
- (b) Advice from the previous owner that the building was not economic to repair.
- (c) After the previous resource consent application to demolish Harley Chambers (along with partially demolishing Worcester Chambers) and building a new hotel, did not proceed, the previous owner undertook another review of the building to assess its economic viability to repair the building. This was undertaken with a joint venture partner experienced with the strengthening of older buildings and with the joint partners own specialist engineers who are also very experienced in the strengthening of older buildings. I provided background information on the building's condition to the engineers but otherwise did not have any input into their reviews. I understand that this team concluded that it was not economic to repair the building.
- (d) With my recent inspection I observed additional damage caused to the building. The costs to repair the building will be increased from my previous knowledge of the repair costs.
- 116 Paragraphs 74-80 focus mainly on the Centraus Report. I offer my comments on the relevant structural items below in response to Mr Hoggs evidence where I generally agree with Mr Hogg's comments on the Centraus Report.
- 117 Part paragraph 78. I have seen and have personally worked on a number of buildings that were in a far more damaged state than the Harley Chambers building and which have subsequently been repaired and rebuilt.

I, like Mr Pearson, have been involved with numerous earthquake damaged buildings, with a wide range of damage. Often in my experience, the repair of a damaged building relates to the economics of the repair. In some cases, there may be supplementary external funding that allows heritage buildings to be repaired/strengthened when it would otherwise be uneconomic to do so. Quoin are currently involved in the strengthening of a heritage building with such significant additional external funding where it would not be economical to retain the building without the external funding. I know for Harley Chambers, that the previous owner, who still owns other heritage buildings and of which we are involved in the strengthening of an undamaged building in Napier, had the best intentions of repairing the Harley Chambers building, but that when the cost estimates were undertaken that this determined for the owner that it was uneconomic to do so. I have observed this same outcome with many buildings and owners.

118 Part paragraph 79. ...By contrast, the Harley Chambers building was constructed of reinforced concrete with steel columns and beams and compared with those other buildings, appears to be relatively intact.

The extent to which a building is damaged needs to be carefully assessed and investigated. While this building includes many sections of reinforced concrete, the reinforcing comprises of low strength nondeformed reinforcing bars, and the detailing is very poor when compared with current standards today. As such, elements such as the concrete columns, appear to be strong and robust, but actually have vulnerabilities that need to be carefully assessed. There are numerous examples of more modern designed and constructed buildings having to be deconstructed in Christchurch following the CES, and often because they were not economic to repair back to a safe minimum strength.

Statement of evidence of Mr Hogg:

- 119 The paragraphs from Mr Hogg's evidence that I wish to clarify or comment on are included below in *italics*, along with my comments. The sections of Mr Hogg's evidence that specifically relate to Submission #1092 Harley Chambers includes paragraphs 19-31.
- 120 I note that the Structural Technical Advice provided by Mr Hogg concurs with all of the major structural issues and is in general agreement with myself on the repair and strengthening works required.
- 121 Paragraph 27(a). The report notes safety concerns about the visible cracks in the northeast corner column and potential for instability in a moderate earthquake. This safety concern could be removed by sufficient temporary propping to eliminate the risk of column instability. Quoin Structural Consultants agree there is no concern of overall building instability. I am unsure why make safe temporary propping has not been installed to date.

I have attended meetings recently with the new Owner and Christchurch City Council engineers to discuss this issue and alternatives to mitigate the safety concerns.

122 Paragraph 27(e). The fire that occurred in the southwest corner at ground level may have caused damage to the concrete and reinforcement at the soffit face of the waffle slab floor. There has been no investigation to confirm if damage has occurred. Propping the floor will eliminate any perceived risk of reduced floor capacity. Carbon fibre laminate strengthening solutions can be developed to reinstate full floor capacity without the need to demolish this portion of the floor.

I have proposed the use of carbon fibre strips elsewhere in the building as an alternative to using reinforce bars or plates. I am less certain about using these in an area where the concrete has been damaged by a fire, as the preparation of the concrete surfaces is a key part of using such carbon strips.

123 Paragraph 28(a). The north-east corner could partially collapse, in its current condition under a moderate earthquake shaking." I disagree with this statement as temporary make safe propping should be installed to eliminate risk of partial collapse. There is no risk of overall building collapse.

I agree with Mr Hogg that the installation of propping will mitigate the collapse risk, but I've been making this recommendation for propping since December 2016 and nothing has been done. So this significant risk remains. I note that the new owner has only just taken ownership of the building and is in ongoing discussions with the Christchurch City Council to discuss options to mitigate the safety issues, both internally and externally to this section of the building.

124 Paragraph 28(b). The concrete canopy apron directly adjacent to the east side footpath is significantly cracked and could partially collapse under moderate earthquake shaking." I disagree with this statement as no investigation has been undertaken to confirm its stability and, in any case, make safe temporary propping can be installed to eliminate this risk.

I agree with My Hogg, but again, but it's difficult to get any propping installed. Given its location directly adjacent to the footpath, part demolition offers a robust and cost-effective longer-term solution.

125 Paragraph 29 on the Centraus Report. I generally agree with Mr Hogg.

Ba Gubmore.

.....

Brett Gilmore 20 September 2023

Appendix A

Quoin Structural Consultants, Structural Report to Accompany Assessment of Environmental Effects and Resource Consent Application, 13 December 2017



Structural Report to Accompany Assessment of Environmental Effects & Resource Consent Application

Quoin Structural Consultants	Project	Harley Chambers & Worcester Chambers
Level 2, 138 Victoria Street Christchurch 8013 PO Box 25 438 Christchurch 8144		Buildings
03 968 4925 quoin.co.nz	Client	Lee Pee Limited
	Address	137 Cambridge Terrace, Christchurch & 69 Worcester Boulevard, Christchurch









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13 December 2017



Quoin Structural Consultants

Level 2, 138 Victoria Street Christchurch 8013 PO Box 25 438 Christchurch 8144

03 968 4925 quoin.co.nz Dr Gerard McCoy QC SCB & Rosie Hobbs Lee Pee Ltd PO Box 2838 Christchurch 8140

By Email: valourproperties@xtra.co.nz

Dear Gerard & Rosie

Harley Chambers Building, 137 Cambridge Terrace, Christchurch & Worcester Chambers Building, 69 Worcester Boulevard, Christchurch

1. Introduction

Quoin Structural Consultants Ltd (Quoin) has been engaged to complete a Structural Assessment Report to accompany the Assessment of Environmental Effects (AEE) and Resource Consent Application being lodged to demolish Harley Chambers, and redevelop the York House, Worcester Chambers and Harley Chambers sites, including some demolition of Worcester Chambers. The main purpose of this report is to summarise the following:

- (a) Describe the existing buildings, their construction, and structural systems.
- (b) Outline the level of investigation undertaken and where information was obtained.
- (c) Summarise earthquake damage caused by the recent Canterbury Earthquake Sequence (CES).
- (d) Review the buildings' performance in the recent Canterbury earthquakes.
- (e) Identify critical structural weaknesses.
- (f) Assess/estimate the building's seismic strength relative to New Building Standard (NBS), commonly referred to as "current code".
- (g) Outline the repairs to restore the buildings to their pre-earthquake condition, and minimum earthquake strength of 34% x NBS for Harley Chambers and 73% x NBS for Worcester Chambers.
- (h) Provide concept design to earthquake strengthen the Harley Chambers Building to 67% x NBS and 100% x NBS.
- (i) Provide concept design to retain the façade of Harley Chambers.





- (j) Provide concept design assessment for the construction effects and management plan for the retention of Worcester Chambers and construction of adjacent new hotel building.
- (k) Highlight Building Act requirements and the Christchurch City Council policy for earthquake-prone buildings.

Quoin (previously Structex Metro Ltd) have had involvement with the inspection and assessment of Harley Chambers since soon after the 4 September 2010. This has included:

- (1) Post-earthquake inspections.
- (m) Assessments of earthquake hazards and damage.
- (n) Providing advice and supervising the safe removal of contents from the building.
- (o) Advising on scope of intrusive investigations and survey of the building.
- (p) Completion of Detailed Engineering Evaluation to assess the building percentage x NBS (damaged and undamaged).
- (q) Develop full scope of structural repairs to assist with the insurance claim, including liaising with the Quantity Surveyor and Insurer's Engineer.
- (r) Concept design for earthquake strengthening of building to 67% x NBS and 100% x NBS.

2. Limitations of Report

Findings presented as part of this report are for the sole use of Lee Pee Ltd. The findings are not intended for use by other parties, and may not contain sufficient information for the purposes of other parties or other uses. Our professional services are performed using a degree of care and skill normally exercised, under similar circumstances, by reputable consultants practicing in this field at this time. No other warranty, expressed or implied, is made as to the professional advice presented in this report.





3. Executive Summary & Recommendations

3.1. Harley Chambers Building

- 3.1.1. The building was constructed in two stages circa 1929 to 1932, with an east-west join between the main north and south section aligning with the south side of the lobby, stairs and entry door to Cambridge Terrace.
- 3.1.2. The building comprises of:
 - Concrete first and second floors, and roof, comprising of 'waffle' type slabs.
 - Timber framed ground floor.
 - Concrete perimeter beams and columns.
 - Concrete walls to some internal walls.
 - Double brick infill to north and west exterior walls.
 - Unreinforced masonry Bell block walls to interior of the north section.
 - Concrete lift shaft to underside of second floor and brick above (part deconstructed).
 - Part concrete basement.
 - Concrete stairs.
 - Shallow concrete foundations comprising of strip footings and pads.
- 3.1.3. Harley Chambers is listed as a Category 2 heritage building in the Heritage New Zealand Register and in the Christchurch District Plan.
- 3.1.4. The building suffered extensive and widespread damage due to the CES. Damage included, but was not limited to:
 - (a) Collapse of brick lift shaft above roof level.
 - (b) Severe and widespread cracking to unreinforced brick and Bellblock walls.
 - (c) Differential settlement of foundations across the full footprint.
 - (d) Cracks in basement walls causing flooding in the basement.
 - (e) The brick infill and parapet to the north wall directly adjacent to the boundary was removed to allow the safe construction of the new adjacent building.





- (f) Widespread cracking to concrete floors, walls and columns.
- (g) Widespread cracking to exterior plaster finishes throughout.
- (h) Severe structural damage to north-east corner column and adjacent foundation beam/wall.
- (i) Widening of the join between the north and south sections.
- (j) Widespread damage to wall and ceiling finishes throughout.
- 3.1.5. The building in its current condition has an assessed earthquake strength of 15% x NBS.

The building in its undamaged pre-earthquake condition has an assessed earthquake strength of 25% x NBS.

The building has been assessed as being earthquake prone, with an earthquake strength of less than 33% x NBS.

- 3.1.6. The building has critical structural weaknesses that include:
 - (a) Unreinforced brick parapets.
 - (b) Unreinforced brick lift shaft above second floor level (part deconstructed above roof.
 - (c) Unreinforced brick and Bell-block walls.
 - (d) Severely damaged column at north-east corner.
- 3.1.7. Overall the extent of the widespread and significant damage is as would be expected for the type of building being subjected to the CES.

In its current condition, the main safety risk to the public is the structural integrity of the north-east column and possibility of small pieces of exterior plaster spalling and falling onto the footpath. These issues have been discussed with the Christchurch City Council. A temporary barricade has been erected adjacent to the north-east corner column.

The main safety risks to personnel, other than the public, include:

- (a) Unreinforced brick parapets to the rear north and west sides of the building. This issue is more significant when the adjacent Worcester Chambers building is occupied, as the space between the buildings is a fire egress route for Worcester Chambers.
- (b) Spalling and falling of loose debris from loose wall and ceiling finishes and broken windows.
- (c) Health issues associated with residual part filled basement and the widespread contamination of the interior due to exposure to pigeon faecal matter.





- 3.1.8. The repairs required to reinstate the building to its pre-earthquake condition and to a minimum earthquake strength of 34%x NBS is extensive. The cost of these repairs as assessed by the Quantity Surveyor, including the reinstatement of the non-structural finishes and services has been assessed as being more than the cost of rebuilding as new.
- 3.1.9. The report outlines the design concepts to earthquake strengthen the building to 67% x NBS and 100% x NBS. These costs are additional to the cost of repairs and strengthening to 34% x NBS.
- 3.1.10. The report outlines the design concept to retain the exterior façade to both the Cambridge Terrace and Worcester Boulevard front elevations. The extent of the works and associated costs to temporarily support, repair and strengthen the façade to be incorporated into a new building is extensive. While it is considered to be structurally feasible to retain the façade, it may not be economic to do so. The retention of the façade may also compromise the design and functionality of any new building behind the façade.
- 3.1.11. The demolition of Harley Chambers has its own challenges with regards to suitable site access and its close proximity to Cambridge Terrace, Worcester Boulevard and Worcester Chambers.

The access to the current site is very limited, with an approximate 2.5m wide access way available via Worcester Boulevard between the Worcester Chambers and Harley Chambers buildings.

Given the importance of Cambridge Terrace and Worcester Boulevard to traffic flows, consideration may be given to the part demolition of the rear 1950s section of Worcester Chambers that would provide a simple access with which to undertake the demolition.

3.2. Worcester Chambers Building

- 3.2.1. The original front section of the building was constructed circa 1928 and it was extended to the rear in 1950.
- 3.2.2. The building is 2-storey and comprises of:
 - (a) Lightweight timber framed roof.
 - (b) Double brick exterior walls above first floor.
 - (c) Concrete first floor, supported on concrete walls and beams and columns. The concrete walls are clad in brick to give the appearance of an all brick building.





- (d) Timber framed ground floor.
- (e) Shallow perimeter concrete footings beneath the loadbearing walls and interior concrete piles, to the front two-thirds of the building. The rear section comprises of a concrete slab on grade and shallow perimeter concrete footings.
- (f) Small semi-basement to east side of building, constructed in concrete.
- (g) Main lateral resistance provided by steel frames in both directions above first floor, together with street braced walls in the east-west direction. The ground floor lateral system comprises of concrete walls in both directions, with concrete first floor diaphragm to distribute loads between walls. The rear section of the building includes concrete frames (beams and columns) in each direction.
- 3.2.3. Worcester Chambers is listed as a Category 2 heritage building in the Heritage New Zealand Register and Category 1 in the Christchurch District Plan.
- 3.2.4. Extensive alterations were carried out in 2007, including earthquake strengthening.

Steel frames are installed laterally to support the brick walls above first floor and independently support the roof trusses.

- 3.2.5. The building suffered damage due to the CES that includes:
 - (a) Weakening of chimney.
 - (b) Spalling of plaster to soffit over the front south walls.
 - (c) A decorative plaster chalice fell to the ground on the east side.
 - (d) Cracking to brick mortar and loosening of some bricks.
 - (e) Settlement to edge of stairwell.
 - (f) Some broken windows.
 - (g) Cracks to interior finishes.





- 3.2.6. Repairs were completed to the above noted items in 2011.
- 3.2.7. The building has been recently assessed by Endel Lust Civil Engineer Ltd to have an earthquake strength of 73% x NBS. No further earthquake strengthening is recommended.
- 3.2.8. The report outlines the main items to be considered for a new building, (with basement), to be constructed directly adjacent to Worcester Chambers. It is structurally feasible to retain the proposed section of Worcester Chambers without unduly affected its structural integrity and strength. This can be achieved by the installation of a permanent tied steel sheet pile retaining system using low vibration equipment, construction of stiff reinforced concrete walls to the basement, tying the existing foundations of Worcester Chambers onto the adjacent new building ground floor structure, and provision of seismic gaps and joints between the superstructures of Worcester Chambers and new adjacent building.




4. Harley Chambers

4.1. Building Description

4.1.1. General Description

Building Name:	Harley Chambers
Address:	137 Cambridge Terrace, Christchurch
Building Use:	Commercial Offices
Heritage Category:	2
Number of Storeys:	3
Basement:	Part concrete wall basement beneath north section of building
Roof Construction	Concrete slab
Wall Construction:	Concrete, brick infill and hollow masonry Bell-block
Floor Construction:	Concrete waffle slab at first and second floors and roof
Subfloor Construction:	Part suspended slab over basement. Timber framed to main building footprint.
Year Built:	1929 to 1932
Approx. Floor Area:	760 m ²
Building Importance:	2 (NZS1170.0)

The Harley Chambers Building is listed in the Heritage New Zealand Register and Christchurch City District Plan as a Category 2 building.

4.1.2. Structural Systems

A summary of the structural systems is as follows:

- (a) The building was constructed in stages with a north building section and a south building section. The join between the building sections occurs at the doors and lobby to Cambridge Terrace.
- (b) Reinforced concrete 'waffle' type suspended floor slabs at the first and second floors, and at roof level. The roof is flat and has a waterproof membrane.
- (c) The north section of the roof is also clad in metal roofing over timber framing that was likely installed at a later date to improve the water tightness of the roof.





- (d) The concrete floors are supported by reinforced concrete perimeter beams at the exterior walls and some steel beams to the interior.
- (e) The concrete beams are supported on reinforced concrete columns. The steel beams are supported on steel columns.
- (f) The exterior wall elevations to Cambridge Terrace and Worcester Boulevard comprise of concrete beams and columns as noted above with decorative plaster finishes and a large portion of windows.
- (g) The exterior walls to the wall elevations not visible from the street, typically comprise of plastered concrete columns and beams with double brick infill to form the walls between the windows. The double brick walls comprise of 2 x 100 thick solid brick skins with a 100mm wide cavity between.
- (h) The walls along the join line of the north and south building sections comprise of a double brick wall with cavity, similar to the exterior wall construction.
- (i) The wall parapets to Cambridge Terrace and Worcester Boulevard comprise of concrete that is likely reinforced and extends above the roof level perimeter concrete beams.
- (j) The wall parapets to the wall elevations not visible from the streets comprise of 270mm overall thick brick infill between 600mm x 330mm concrete piers at 1800/2100mm centres that appear to extend from the concrete perimeter beams and columns below.
- (k) The lift shaft above roof level comprise of solid brick construction with a concrete slab roof. The brick walls appear to extend down to the second floor level. The walls below the second floor appear to comprise of 225mm-300mm thick concrete.
- (1) The part basement beneath the north section of the building comprises of concrete walls and base slab.
- (m) The ground floor comprises timber flooring on timber joists and bearers over shallow concrete piles, that extend over the main building footprint. The section of ground floor over the basement comprises of a reinforced concrete suspended slab.
- (n) Most of the interior partition walls to the north section comprise of 130mm wide hollow masonry Bell block that is not reinforced. The walls are constructed hard up against the underside of the concrete suspended floors and may be partially load-bearing for the floor live load and possibly some of the gravity load. The Bell blocks comprise of soft brittle masonry.
- (o) The main interior stairs located at the north section of the building are reinforced concrete.





- (p) The foundations typically comprise of shallow reinforced concrete pads and strip footings beneath the columns and load-bearing walls respectively.
- (q) The main lateral resisting systems comprise of a combination of concrete walls, concrete frames, concrete frames with brick infill, and hollow masonry Bell block partition walls.

4.2. Investigations

- 4.2.1. The building evaluation and assessment has been based on the following:
 - (a) Numerous visual inspections of the building carried out following the 4 September 2010 earthquake. This included several Level 2 Assessments and included inspection of the following:
 - The exterior from ground level.
 - The interior spaces at all floor levels.
 - The roof decks.
 - The basement.
 - The lift shaft.
 - (b) Limited structural/architectural drawings/floor plans were obtained from Lee Pee Ltd. These included the following drawings titled:
 - 'Medico Dental Buildings, Cambridge Terrace, Christchurch for EA Suckling Esq'.
 - Drawing No. 1: Floor Plans and Sections
 - Drawing No. 4: Details of Steel Construction
 - Drawing No. 5: Details of Steel Reinforcing (Floors, columns, beams and foundations

The above noted drawings document the north building section only. The south building section is constructed similarly to the north, except that it has some added interior concrete walls, and no interior Bell block walls.

- (c) A site specific geotechnical investigation and report has not been completed for this building site. From our experience of other sites in the nearby vicinity of the Harley Chambers Building that include the York House site at 65-67 Worcester Boulevard, and at 141 Cambridge Terrace, the soil conditions comprise of the following:
 - Below the surfacing materials there is likely a layer of fine grained silt and/or silty sand. This layer may vary from 1.0m-3.5m in depth where a sandy gravel is encountered. This gravel is part of a formation which extends from





about Armagh Street in the north to south of Tuam Street and well west of Rolleston Avenue to east of Colombo Street. The gravel generally extends to 8m-10m depth and is 6m-7m thick. The gravel is likely underlain with a sequence of predominantly sand and silty sand layers, although thin layers of silt and peaty silt could be present.

- The water table is likely to be approximately 1.5m-3.0m below ground level. Following the recent earthquakes, a spring occurred at the north-east corner of the site and caused ingress of water into the basement. The basement remains partially filled despite attempts to pump the water out.
- The site is a Class D 'soft' site in terms of the seismic design requirements of AS/NZS 1170.
- There is a moderate risk of liquefaction occurring on the site.
- All the major buildings in the area between Tuam Street and Armagh Street, Rolleston Avenue and Colombo Street, including the Police Station, Clarendon Towers, the Art Gallery and HSBC Tower are all founded on the near surface gravel layer, which generally provides good bearing for shallow foundations. It is generally of sufficient thickness and density to act effectively as a raft, to spread variability in loadings from individual pad footings and minimise any potential for differential settlement in the underlying sands or soft silt lenses.
- It is noted that York House at 65-67 Worcester Boulevard suffered severe differential settlements and superstructure damage following the recent earthquakes and has since been deconstructed.
- (d) The following on-site investigations have been carried out under the direction of Quoin:
 - The investigation work to date has been completed in the north section of the building as this is where much of the significant damage has occurred and is the part of the building that some existing drawings have been found to assist with the structural assessment and review. The south section of the building is constructed similarly to the north section.
 - A floor level survey of the first and ground floors to both the north and south sections of the building. (Refer Appendix C).
 - Removal of some of the carpet floor finishes in the north section of the building to review the cracks in the ground floor suspended concrete floor slab over the north side of the basement.





- Removal of some of the wall finishes in the north section of the building, together with drilling holes in various walls, to confirm their thickness and material construction.
- Pumped out basement several times to allow inspection of walls and base slab.
- Completed make safe works, including removal of the brick wall lift shaft above roof level, replacement of broken windows and temporary bracket installed to roof parapet at the joint between the north and south building sections.

The following non-structural aspects fall outside the scope of this report and have not been covered by this investigation and assessment:

- Detailed review of non-structural finishes, fixed joinery, windows and doors etc.
- Compliance items covered by the building Warrant of Fitness.
- An electrical safety review.
- A fire safety review.

These items should be inspected and assessed by qualified trades people or specialists prior to the building being reoccupied or repair/strengthening works carried out. We request such persons be instructed to identify loose and/or inadequate fixings, and to notify the engineers if these are found.

4.3. Building Performance in recent Canterbury Earthquakes

4.3.1. Earthquake Damage

The building has suffered significant earthquake damage as summarised in Appendix B and D. Most of the significant damage occurred to the superstructure in the north section of the building together with differential settlements across the full footprint of the building.

4.3.2. Review of Building Performance

The building as a whole has performed as would be expected for its age and construction. The main areas of damage include:

(a) The unreinforced brick walled lift shaft suffered significant damage above the roof level and was subsequently temporarily secured following the 26 December 2010 earthquake and then deconstructed following the 22 February 2011 earthquake.





- (b) Differential settlement of the foundations across the full footprint of the building, with some severe settlement occurring at the north-east corner of the building. This may be due to some liquefaction occurring in subsoil layers and/or the result of a spring being activated near this corner due to the earthquakes.
- (c) The main lateral resisting systems appear to comprise of a combination of the following:
 - Reinforced concrete frames
 - Reinforced concrete frames with solid/partial unreinforced brick infill.
 - Unreinforced hollow masonry Bell block partition walls.
 - Reinforced concrete shear walls.
 - Numerous cracks have occurred in the interior unreinforced brick and unreinforced masonry Bell block partition walls. This damage suggests that these walls have provided a substantial amount of the building's stiffness and resisted a proportional amount of the lateral earthquake loads.
 - The construction joint between the north and south sections of the building has suffered differential movement that has caused a 10-20mm gap to open up along the line of the joints over the full height of the building.

4.3.3. Critical Structural Weaknesses (CSW)

From a review of existing drawings and visual inspections of the building, the following critical structural weaknesses were identified:

- (a) Unreinforced brick parapets to the sides of the building that do not front onto Cambridge Terrace or Worcester Boulevard. The construction of these is as described in section 4.1. The extent of earthquake damage generally appears low except for the parapet to the north wall which has since been deconstructed.
- (b) The north wall parapet was deconstructed to ensure that the new building at 141 Cambridge Terrace could be constructed safely. The section of the brick parapets suffered the worst damage.
- (c) In its current state, there does not appear to be a risk of the parapets falling or suffering partial collapse. The parapets should be re-inspected following any significant earthquake aftershocks.
- (d) The unreinforced brick walls to the lift shaft above the roof level were a critical structural weakness and subsequently removed.
- (e) In its current state, the north-east corner column that has suffered severe cracking damage and is a critical structural weakness.





Refer to section 4.4 Seismic Assessment for discussion of the building strength in the undamaged and damaged states.

4.4. Seismic Assessment

A preliminary seismic assessment of the building has been carried out in general accordance with the New Zealand Society for Earthquake Engineering (NZSEE) "Assessment and Improvement of the Structural Performance of Buildings in Earthquakes" guidelines (June 2006).

AS/NZS1170.5:2005 was used to determine the applied loadings to the building. A zone factor (Z) of 0.3 was adopted in accordance with changes to Section B1 of the Building Code, which came in to effect on the 19^{th} May 2011.

NZSEE guidelines (June 2006), and standards AS/NZS3101:2006, AS/NZS3404:1997 and AS/NZS3603:1993 have been used to assess the building capacity.

The building has initially been assessed as an Importance Level 2 (normal) building. A summary of the assumptions includes the following:

•	Importance Level 2 (IL2)	= normal
•	Soil class	= D (soft)
•	Sp	= 1.0
•	Ductility μ	= 1.25 (low)
•	Period T	= 0.4 seconds (low)

We note that while the Buildings Act "deems a building earthquake prone if its ultimate strength capacity is exceeded, and the building would be likely to collapse", the NZSEE guidelines and CCC policy refer to a percentage of New Building Standard (%NBS). The ultimate limit state capacity of the building has been assessed as a percentage of NBS to allow comparison.

The following table summarises the results of our assessment. Elements that have less than 33% of current code strength are regarded as being earthquake prone and are highlighted in bold.

It is noted that the behaviour of the building is complex due to the combination of the various systems.

The assessment table below summarises the estimated in-plane earthquake capacity of the building for the following:

- (a) Assessed design strength (undamaged), with the main building lateral resistance provided by unreinforced brick and hollow masonry Bell block walls, plus concrete shear walls, plus some concrete frames.
- (b) Assessed residual strength (damaged), with the main building lateral resistance provided by some concrete shear walls and frames. This assessment assumes that the main damaged walls do not contribute to the lateral resistance.





(c) The % x NBS is given below is for the critical north section of the building.

North Section of Building (critical section for assessment) Estimated % x New Building Standard (% x NBS) Assessed Design Strength at Ground Level (undamaged) (a) (i) East Wing North-south direction 30% x NBS East-west direction 35% x NBS (ii) West Wing North-south direction 40% x NBS East-west direction 25% x NBS (b) Assessed Design Residual Strength (damaged) (i) East Wing North-south direction 25% x NBS 15% x NBS East-west direction (ii) West Wing North-south direction 25% x NBS East-west direction 20% x NBS

The assessment indicates that the north section of the building has an assessed (undamaged) design strength of $25\% \times NBS$ and a residual (damaged) strength in its current condition of $15\% \times NBS$.

With all of the walls in an un-cracked condition, the building has reasonable lateral resistance and provides an indication as to why the building performed as expected.

The damage caused to many of the ground level brick and hollow masonry Bell block walls has weakened the building. The preliminary assessment of the residual lateral strength confirms that the building is considered as earthquake prone with a capacity less than 33% x NBS.

It is noted that the reinforced concrete walls, frames and columns do not comply with the current NZS 3101 Concrete Structures Standard, which is understandable given the age and construction of the building. This means that these key structural elements have little or no additional ductility to dissipate seismic energy and withstand increased imposed lateral displacements.





The reinforced concrete beams, columns, slabs and walls are lightly reinforced, with much of the reinforcing comprising of non-deformed bars. The detailing of the reinforcing includes short length laps and widely spaced stirrups, both of which are considered to be poor detailing with respect to current design standards.

The building is considered to be structurally repairable and may be strengthened to increase its reliable design lateral strength to 34%-100% x NBS as required. However, the extent of works to repair the building back to its pre-earthquake condition and undertake at least nominal strengthening to 34% x NBS is significant.

Refer to Section 4.5 Earthquake Repairs and Concept for Strengthening Work.

4.5. Earthquake Repairs and Concept for Strengthening Works

This section briefly describes repair works to restore the building to its preearthquake condition, and additional works to strengthen the building to 34%-100% of current code. In some cases, further investigation of existing construction will be required. Where appropriate, this has been noted.

Repair and strengthening work proposed in this report have sought to preserve heritage features as much as possible. Such features include decorative corbels and pillars on the external façade and the waffle slab suspended floor system.

4.5.1. Repairs

This section describes the main scope of structural repairs to restore the building to its pre-earthquake condition. The scope is preliminary and subject to further detailed investigations, analysis and design.

The costs associated with the repairs will be assessed by a Quantity Surveyor Refer to the sketches and Earthquake Repairs Summary Table in the Appendices.

(a) Repairs to interior hollow Bell block masonry partition walls:

- These walls have a large height:thickness aspect ratio plus the material has been found to be very low strength.
- Remove all Bell block partition infill walls. Reinstate with 140mm masonry block, solid filled with H12 @ 400mm each way. Drill and epoxy H12 starters, 1000mm long, 200mm into all adjacent columns, beams, floors and foundations. Refer to sketches SKR2/R3 and R4.
- Allow to construct 50m of 150mm wide x 350mm deep rib in 0.6m long sections within existing first and second floors to accommodate starters for block walls that do not align with existing floor ribs. Refer to sketch SKR20.





- (b) Repairs to all double brick infill walls and parapets in the north section and 5.0m beneath four windows in the south section. Refer to SKR4.
 - Remove double brick walls and reinstate with solid filled 240 masonry block. Reinforce with H12 @ 400 each way. Drill and epoxy H12 starters into all adjacent columns, beams, and foundations, to match locations and spacings of main reinforcing. Reinstate plaster as required. Refer to sketches SKR2 to SKR4 inclusive.
- (c) Repair and reinstate walls to lift shaft:
 - Deconstruct remaining lift shaft walls down to foundation level and reconstruct. Refer to sketches SKR1 to SKR4 inclusive and sketch SKR9.Reinstate concrete roof slab, 150mm thick, reinforced with H12 @ 300 each way, and provide new 200 UB 30 lifting beam.
- (d) Repair junction between the north and south building sections:
 - Break out part sections of the main structural floors, beams and parapets, and reinstate with new tie connections with epoxied reinforcing. Refer to sketches SKR17 and SKR18. Fill joint gap with grout.
- (e) Repair to concrete wall at north wall of lobby:
 - Reconstruct as part of the basement reconstruction. Refer to sketch SKR2.
- (f) Leaking Basement repairs:
 - Address issues with spring.
 - Reconstruct the basement walls and slab with new tanking system, including temporary propping and support works. Refer to sketches SKR5 to SKR11 inclusive.
- (g) Repair concrete ground floor slab over north end of basement:
 - Reconstruct as part of the basement reconstruction works.
- (h) Repair expansion joint between Harley Chambers and adjacent north building at 141 Cambridge Terrace:
 - Remove existing expansion joint flashings and material.
 - Measure and check gap between buildings.
 - Assuming that the gap is of acceptable width, reinstate expansion joint flashings etc.





- (i) Foundation re-levelling and repairs across the building footprint:
 - For the north section Underpin and jack foundations using steel screw piles to approximately 3.5m depth below ground level. Note that this excludes area of basement. Interior piles supporting timber floor only and strip footings to Bell Block walls to be reconstructed. Refer sketch SKR1 and attached screw pile information SP1-SP11 inclusive. Allow for 40 piles to be jacking piles, plus allow to ground 50mm beneath 90 square metres of foundation. Refer sketch SKR21 for methodology.
 - For the south section Underpin and jack foundations using steel screw piles. Lesser number of jacking piles required than north section. Interior piles supporting timber floor only to be reconstructed. Refer attached sketch SKR12 and attached screw pile information. Allow for eight piles to be jacking piles, plus allow to grout 30mm beneath 40 square metres of foundation. Refer to sketch SKR21 for methodology.
- (j) Repair cracks in concrete beams, columns, floors and walls.
 - Epoxy inject all cracks. Refer to sketches SKR2, SKR15 and SKR16 and items 106, 111, 112, 113, 114, 115 and 116 in the Repair Table.
 - Reconstruct columns at north-east corner and next adjacent column.
- (k) Provide all temporary propping as required to undertake the repairs. Refer to items 130 and 131 in the Repair Table.
- (1) Repair to damaged internal wall and ceiling linings.
- (m) Remove all wall and ceiling linings and reinstate as new. Cracks in exterior plaster:
 - Remove damaged sections and reinstate.
- (n) Other non-structural repairs:
 - Ease and adjust any jammed/catching doors/windows etc.
 - Realign and re-fix any dislodged timber architraves, frames, skirting boards and trims.
 - Sand, prime and repaint over to match existing.
 - Repair/replace broken windows and frames as required.





4.5.2. Concept for Strengthening to 34% x NBS

In addition to the repairs outlined in the previous section 4.5.1, the following work is likely required to strengthen the building to 34% of current code. Refer to sketch in Appendix H that outlines these additional items for the north section of the building. Similar strengthening work would be required for the south section of the building.

• Remove the double brick walls at the interface of the north and south building and at the north, west and 'central' walls as shown on sketch SK11 over the full height, and reinstate with new 240 reinforced masonry block.

4.5.3. Concept for Strengthening to 67% x NBS

In addition to the repairs outlined in the previous section 4.5.1, the following work is likely required to strengthen the building to 67% of current code. Refer to sketch SK12 that outlines these additional items for the north section of the building that generally includes:

- (a) Provide new 300mm thick reinforced concrete shear walls at locations shown, full height of building, unless noted otherwise.
- (b) Provide new 400mm thick insitu concrete frame columns and beams to east wall elevation.
- (c) Reconstruct lift core walls as new, including lift pit.
- (d) Provide new foundations for the above. Allow for 800mm deep, typical.
- (e) Provide enhanced floor diaphragm ties as shown (reinforcing epoxied into chases in floor slab and/or carbon fibre reinforced polymer strips (CFRP).
- (f) Remove all hollow masonry Bell block partition walls and replace with lightweight non-structural partitions.
- (g) Add new 150mm thick skin walls to South section of building, as shown on SK16.
 - Reinforce the skin walls with H12@200 each way.
 - Drill and epoxy D10 hooked ties into the existing wall (100mm embedment) @ 600crs each way.
 - Allow to drill through existing floors to allow vertical bars/starters to pass through.
 - Allow to drill and epoxy vertical H12 starters into the underside of the roof slab/floor.





- (h) Add new 250mm thick shear walls to south section of building, as shown on SK16.
 - Reinforce the walls with H16@200ew, each face. Provide HR10 strips (600mm long) plus 2HR10 links, all spaced at 100 centres, at each end of the wall, over the bottom storey height.
 - Drill and epoxy D10 hooked ties into faces of the existing columns where the new wall is parallel to the adjacent to existing wall (100mm embedment) @ 600mm centres each way.
 - Allow to drill through existing floors to allow vertical bars/starters to pass through.
 - Allow to drill and epoxy vertical H12 starters into the underside of the roof slab/floor.
 - Allow to drill and epoxy H16 horizontal starters into the existing columns at the ends of the new shear walls (H16@200 centres, x 1000lg, with 250mm embedment).
- (i) Cut back the existing concrete shear walls at two locations as shown on SK17. The reason for this is to provide similar length walls across the footprint which provide for a better distribution of earthquake loads between walls.
- (j) All of the perimeter columns to the south and north sections of the building are to be strengthened using Sika CarboDur, as shown on SK18. This will require the exterior plaster to be removed, as at least is partly allowed for in the repair scope, and plaster to be reinstated after.
- (k) The foundations shown for the repairs are considered to be adequate for the 67% strengthening, except that need to provide new 800 x 1000d foundation beams beneath 3 of the 4 proposed new shear walls, plus add 4 piles.
- The floor diaphragms will need to be strengthened. Refer to sketch SK12 for the north section. For the south section, allow 200m of CarboDur strips, per each of the first and second roof levels.

It is noted that further detailed investigation, analysis and design is required to develop this option further.

4.5.4. Concept for Strengthening to 100% x NBS

In addition to the repairs outlined in the previous section 4.5.1, the following work is likely required to strengthen the building to 100% of current code. Refer to sketch SK12 that outlines these additional items for the north section of the building that generally includes:





- (a) Provide new 300mm thick reinforced concrete shear walls at locations shown, full height of building, unless noted otherwise.
- (b) Provide new 400mm thick insitu concrete frame columns and beams to east wall elevation.
- (c) Reconstruct lift core walls as new, including lift pit.
- (d) Provide new foundations for the above. Allow for 1000mm deep, typical.
- (e) Provide enhanced floor diaphragm ties as shown (reinforcing epoxied into chases in floor slab and/or carbon fibre reinforced polymer strips (CFRP).
- (f) Remove all hollow masonry Bell block partition walls and replace with lightweight non-structural partitions.
- (g) Add new 200mm thick skin walls to South section of building, as shown on SK17.
 - Reinforce the skin walls with H16 @ 200mm each way.
 - Drill and epoxy D10 hooked ties into the existing wall (100mm embedment) @ 600mm centres each way.
 - Allow to drill through existing floors to allow vertical bars/starters to pass through.
 - Allow to drill and epoxy vertical H12 starters into the underside of the roof slab/floor.
- (h) Add new 250mm thick shear walls to south section of building, as shown on SK17.
 - Reinforce the walls with H16 @ 200mm each way, each face. Provide HR10 strips (600mm long) plus 2HR10 links, all spaced at 100mm centres, at each end of the wall, over the bottom storey height.
 - Drill and epoxy D10 hooked ties into faces of the existing columns where the new wall is parallel to the adjacent to existing wall (100mm embedment) @ 600mm centers each way.
 - Allow to drill through existing floors to allow vertical bars/starters to pass through.
 - Allow to drill and epoxy vertical H12 starters into the underside of the roof slab/floor.
 - Allow to drill and epoxy H16 horizontal starters into the existing columns at the ends of the new shear walls (H16 @ 200mm centres, x 1000lg, with 250mm embedment).





- (i) Cut back the existing concrete shear walls at two locations as shown on SK17. The reason for this is to provide similar length walls across the footprint which provide for a better distribution of earthquake loads between walls.
- (j) All of the perimeter columns to the south and north sections of the building are to be strengthened using Sika CarboDur, as shown on SK18. This will require the exterior plaster to be removed, as at least is partly allowed for in the repair scope, and plaster to be reinstated after.
- (k) The foundations shown for the repairs are considered to be adequate for the 100% strengthening, except that need to provide new 800 x 1000d foundation beams beneath 5 of the 6 proposed new shear walls, plus add 6 piles.
- (1) The floor diaphragms will need to be strengthening. Refer to sketch SK12 for the north section and increase the extent by 100% for the north section. For the south section, allow for 400m of CarboDur strips, per each of the first and second roof levels.

It is noted that further detailed investigation, analysis and design is required to develop this option further.

4.6. Retention of Façade

The façade to Harley Chambers could be retained and incorporated into a new building development. There are likely to be substantial additional works and cost to achieve this and the proportions of the façade may also compromise the design and functionality of any new building behind the façade.

It is noted also, that the façade has suffered earthquake damage that includes differential settlement of the foundations, severe damage to the north column and foundations, widening of the join between the north and south sections and widespread cracking of the plaster and concrete columns to the entry canopy.

The retention of the façade will require the installation of temporary steel bracing frames, underpinning and relevelling of parts of the foundations, completion of the earthquake repairs and strengthening of the façade to 100% x NBS as would be required for integrating the façade into a new building.

The steel bracing frames would likely be located on the inside of the building, rather than on the outside where they would provide significant disruption to the footpath and roads.

Briefly, the methodology, repairs and strengthening to the façade would involve:

- (a) Remove windows.
- (b) Install steel screw piles. Allow for underpinning piles to perimeter foundation plus back-span beams and piles, as per the Earthquake Repair Scope. Refer to sketches SKR1 and SKR13, and details of piles as part of the sketch package for repairs.





- (c) Construct foundations for the temporary steel bracing frames. These foundations and piles will be permanent and designed to form part of the new building.
- (d) With having a timber ground floor adjacent to the full façade perimeter, except at the entry where there is the basement, this allows the steel screw piles to be installed from the outside of the building. Access would be via the windows that would need to be removed as part of this process. This will require traffic control and temporary disruption to footpaths and roads.
- (e) Install steel frames and walers with drilled and epoxied fixings into the inside face of the façade. Bolts will need to be drilled in as deep as possible. Refer to sketch SKF1 for typical steel bracing frame.
- (f) The bolts are not required to pass through to the exterior as the structural sections of the façade comprise of nominally reinforced concrete.
- (g) The entry section canopy to the Cambridge Terrace section will require full propping due to its current damaged condition.
- (h) The north end corner of the building will need to be propped due to the severe damage to the corner columns.
- (i) The north end column and approximately 4m of the adjacent foundation beam/wall next the footpath need to be reconstructed due to earthquake damage. It is recommended that the column is reconstructed over the full height of the building/façade.
- (j) This new column and foundation beam/wall will be reinforced per current design codes and tied back into the existing façade and new building structure in due course.
- (k) The re-levelling of the foundations at this end of the building beneath the façade will likely require reconstruction of the footpath to 15m from the north-east corner. The remainder is underpinning and should not affect the remainder of the footpath.
- (1) Demolish existing building. Currently there is no reasonable access that would allow for a 'straight forward' demolition behind the façade.
- (m) Given the importance of Cambridge Terrace and Worcester Boulevard to traffic flows, consideration may be given to the part demolition of the rear 1950s section of Worcester Chambers that would provide a simple access with which to undertake the demolition.
- (n) All of the perimeter columns to the façade are to be strengthened to 100% x NBS. This will use Sika Carbadur strips to all sides of the columns as shown on sketch SK18 (see attached as part of 67-100% strengthening). This will require the exterior plaster to be removed, as at least is partly allowed for in the repair scope, and plaster to be reinstated after.





- (o) Connect new building to façade.
- (p) A significant portion of the exterior plaster to the façade is required to be removed and reinstated as part of the earthquake repairs and strengthening.
- (q) The existing joint between the north and south sections of the building, that has opened up in the façade adjacent to Cambridge Terrace, is required to be tied together as part of the earthquake repairs and strengthening and is also recommended for the retention of the facade. This will involve:
 - Break back exterior face of the façade to 300mm each side of the joint, and to 150mm depth over the full height of the building.
 - Drill and epoxy H12 ties into each end face of the existing face, at 300mm centres over the full height.
 - Provide 4-H12 vertical full height.
 - Fill cut-out section with self-compacting concrete.
 - Install 400 x 400 x 12 steel plates to the inside face of the façade, with 4 epoxied M16 bolts (2 each side of existing joint), and spaced at 1000mm centres over the full height.
 - Reinstate plaster finishes.
- (r) The extent of crack repairs to the concrete will need to be assessed after removal of the cracked plaster. Some epoxy injection work may be required.
- (s) Extensive repairs are required to cracks in the concrete canopy over the main entry and to the adjacent circular columns. It is recommended that a single RB25 steel rod be drilled down the middle of the circular columns, and post tensioned, as part of the required strengthening.
- (t) Some supplementary strengthening will be required to the concrete canopy. This is likely to comprise of cutting 50mm x 50mm chases into the soffit of the concrete at 300mm centres (north-south) and grouting in H12 reinforcing bars. This will be the closest like-for-like option, without provide supplementary external structure.
- (u) Reinstate windows, which are part of the repairs.
- (v) Re-paint façade.
- (w) The above noted works to retain the façade are extensive and likely to cost significantly more than the cost of a façade to a new building. But from a structural engineering perspective, it is feasible.





- (x) It is noted that the retention of the façade could compromise the design of any new building behind the façade. The proportions of the façade would determine the floor to floor heights and the level of the ground floor relative to the footpath. That could negatively impact on the efficiency and functionality of the design.
- (y) There may be added costs to accommodate disabled access into the building, if the new ground floor level were to match the existing level that works well with the façade, as compared with a new building normally having its ground floor level just above footpath level.

4.7. Demolition

The demolition of Harley Chambers has its own challenges with regards to suitable site access and its close proximity to Cambridge Terrace, Worcester Boulevard and Worcester Chambers.

For this type of building, the methodology for full or part demolition would require access for high capacity equipment that has the capability to break the structure down in a safe and controlled manner. The use of smaller sized equipment may be possible but is likely to be slow and inefficient.

The access to the current site is very limited, with an approximate 2.5m wide access way available via Worcester Boulevard between the Worcester Chambers and Harley Chambers buildings.

Consideration also has to be given to protecting Worcester Chambers and have equipment work a safe and adequate distance away.

Given the importance of Cambridge Terrace and Worcester Boulevard to traffic flows, consideration may be given to the part demolition of the rear 1950s section of Worcester Chambers that would provide a simple access with which to undertake the demolition.

Without restrictions as to access, it is estimated that demolition of Harley Chambers, and the safe removal of material and debris would take four (4) weeks.





5. Worcester Chambers

Refer to the Quantitative Engineering Evaluation Report completed by Endel Lust Civil Engineer Ltd in Appendix K that includes the following:

- 5.1. Preliminary
- 5.2. Address
- 5.3. Site
- 5.4. Description of Building
- 5.5. Structure
- 5.6. Foundations
- 5.7. Damage
- 5.8. Remedial Work
- 5.9. Assessment

5.10. Conclusions

Refer to the Quantitative Engineering Evaluation Report 'Worcester Chambers' 69 Worcester Street for '69 Worcester Limited by Endel Lust Civil Engineer that follows as Appendix K.

5.11. Construction Effects & Management Plan for Retention of Worcester Chambers & Construction of Adjacent New Hotel Building

5.11.1. **Proposal & Overall Construction Responsibilities**

The proposal is as described in the Planning Report. Very briefly, the proposed development is for the construction of a new hotel across the sites that include Harley Chambers, the rear of Worcester Chambers and the previously deconstructed York House.

The Worcester Chambers building has been assessed as having an earthquake strength of 73% x NBS.

The Worcester Chambers building has a good distribution of lateral resisting walls and frames. Therefore, it is likely that no added strengthening would need to be undertaken if the section of the building to be retained, and only added works would be required along the line of the building where it is cut back, as would be expected.

As is typically the case for a project of this nature, a main contractor is proposed to be appointed to carry out the construction works. The main contractors' responsibilities will include management of any subcontractors engaged for the development. The piling work may be carried out as a separate contract.

The main contractor will be required to appoint a Site Manager who will be responsible for the implementation of a Construction Management Plan. The Site Manager will have a range of responsibilities, which will include a liaison role to address any construction related issues that may arise, and which impact on the surrounding environment.





5.11.2. Time Frame

The project will be undertaken over a period of approximately 2.5 years.

5.11.3. Description of Work Activities

The project works includes the construction of a new hotel adjacent to the Worcester Chambers building as indicated on the Concept Architectural drawings. The hotel includes the construction of the underground carpark, and low height glazed atrium directly adjacent to the east, north and west sides of Worcester Chambers. A brief description of the main works is set out as follows.

- (a) Carefully deconstruct Harley Chambers and rear section of Worcester Chambers.
- (b) Install a permanent ground retention system around the perimeter of the Worcester Chambers building and overall site to allow construction of the basement. This would likely involve the following, subject to detailed design:
 - Retention system likely to be installed approximately 0.6m-1.0m away from Worcester Chambers.
 - Steel sheet piling using low vibration equipment.
 - Install near horizontal ties beneath the foundations of Worcester Chambers to tie the top of the sheet pile walls together.
 - Part excavate and install horizontal steel walers near the top of the sheet piling, and temporary braces that extend from the walers down to temporary foundations at the level of the new basement.
 - Complete full excavation for the basement, construct the foundations, and utilise the steel sheet piling as permanent formwork to construct the concrete walls to the basement.
- (c) Construction of concrete foundations to the basement.
- (d) The foundations of Worcester Chambers to be laterally tied into the new ground floor level slab and beams to the new building as construction of the building proceeds.
- (e) The design of the basement structure adjacent to Worcester Chambers to incorporate laterally stiff elements on all sides of Worcester Chambers (eg walls and/or steel braced frames) so that the performance of Worcester Chambers remains unchanged.
- (f) Typically provide seismic joints and gaps between Worcester Chambers and the new building, above ground floor level only. There may be sections of Worcester Chambers where the new building adjoins via flashings, sliding joints, corbels etc.





5.11.4. Construction Management Plan

- (a) All construction projects have construction related effects and project of this scale is no different. A construction management plan (CMP) is therefore a key ongoing tool for systematically managing these effects so that they can be minimised to the extent practicable. A construction management plan is not intended to be a rigid or inflexible document, rather it can evolve as more detail is developed on the various construction aspects of the project.
- (b) There are numerous templates available for developing a CMP, however the majority will include a range of key features which have been incorporated into the attached draft. These include
 - Regular site meetings
 - Management of Dust, Noise and Vibration
 - Establishment of a Complaints Protocol.
- (c) Site Meetings

During construction a weekly formal site meeting will occur. Those present at these meetings will include:

- The Engineer to the contract and/or his representative.
- The Contractor.
- Any other personnel considered necessary.

Matters to be addressed at every site meeting will include a review of the ongoing work programme and any matters that have arisen since the previous meeting.

(d) Noise, Dust & Vibration

There are a range of management measures proposed within the CMP to address these particular effects: They include:

- Where required, machinery is to be muffled so that they comply with the limits for construction noise as set out in the Christchurch City Plan. Construction noise and vibration is to comply with New Zealand Standard NZS 6803:1999 'Acoustics Construction Noise.
- The Contractor is to provide the Engineer with certification for each piece of heavy machinery and its compliance with the relevant noise limits.
- No work is permitted on Sundays or public holidays.





- The Contractor is to have a water cart and/or water sprinkler equipment available during the earthworks activities to be used to supress dust during dry or windy periods; and
- Vibration from earthworks machinery is to be monitored by the Site Manager and Engineer and if found to be excessive then alternative methods of construction employed. This is to be discussed between the Engineer and Site Manager at the time of the works.
- (e) Complaints Protocol
 - It is important for the Contractor to be constantly aware of possible impact construction effects will have on neighbours and to be responsive to concerns raised.
 - This in mind, the CMP requires a register is to be kept by the Site Manager of any complaints received from the public or the Council. This register is to be available for viewing by the Engineer and the Council. The Site Manager is to investigate each complaint made and make recommendation to the Engineer on how to rectify the problem. The Engineer will then, if necessary, instruct the Site Manager to undertake the work as appropriate.
 - If a complaint is received from or via the Council then the Site Manager is to keep Council and the Engineer informed of remedial measures taken, where required.
 - A notice board will be erected next to the site entrance. The notice will identify the Site Manager, and the appropriate contact details so as to ensure they are readily contactable by neighbours.
- (f) Access to the Site

Access to site is to be provided off Worcester Boulevard. Due to the nature of the area, care is to be taken for the establishment of large equipment and the delivery of bulk materials.

(g) Site Maintenance

The site is to be maintained in a tidy state at all times. Any rubbish is to be removed on a weekly basis. Materials are to be stored in tidy stockpiles. The Engineer will inspect the site on a weekly basis and will instruct the Site Manager to rectify any areas of the site that is left untidy.

(h) Sediment Control

A sediment control plan is to be submitted to the Engineer for approval and submitted to Christchurch City Council before construction works commence. The sediment control plan is to follow ECAN Erosion & Sediment Control guideline 2007.





(i) Traffic Management

A traffic Management Plan (TMP) is to be developed by the Contractor identifying how material supplies and mechanical plant are to be delivered to site. A copy of the TMP is to be held on site. The TMP is to be submitted for approval by Christchurch City Council before construction works commence.

(j) Conclusion

A project of the scale and nature of the current proposal will inevitably have construction related effects. These effects will be managed by, amongst others the conscious choice to use vibration free sheet piling for the basement car-park and also by the adoption and implementation of an ongoing construction management plan. Such plans are a tried and tested approach to the management of construction effects and in this case will help to manage these effects to an acceptable and appropriate level.

5.12. Assessment of Alternative Options to Retain Sections of Worcester Chambers

The following assesses the structural feasibility of retaining varying portions of the front section of Worcester Chambers.

The options to be considered are as generally described in the Planning Report. These include:

- (a) Option A: 6.5m Retention
- (b) Option B: 13.0m Retention
- (c) Option C: Full Retention

5.12.1. Option A: 6.5m Retention

The structural requirements to retain the front 6.5m of Worcester Chambers are as generally described in Section 5.11.2.

The proposed works involve the use of traditional methodologies that have been used on numerous projects where existing buildings are to be retained, underpinned, and integrated with new adjacent buildings. The methodologies take into account the relative heavy weight of the superstructure (concrete first floor, brick and concrete walls, and concrete foundations), and utilise systems that minimise the effects on the existing building to be retained, including eliminating the need for adding supplementary structure within the retained building and minimising the risk of causing any consequential damage during the retention process.





5.12.2. Option B: 13m Retention

Quoin have considered various sub-options to retain the front 13m of Worcester Chambers as follows:

5.12.2.1 Option B1: 13m Retained Superstructure on Existing Ground

It is noted that the superstructure to Worcester Chambers as summarised in Sections 5.4 Description of Building and Section 5.4 Structure includes very heavy elements such as the concrete first floor, brick and concrete walls and concrete foundations.

The simplest and least risk option is to retain the superstructure as described in Option A. The only difference is that the footprint of the retention is larger, which is likely to affect the functionality of the spaces above and below ground level.

5.12.2.2 Option B2: 13m Retained Superstructure Part Transferred Over Basement

This option retains the front 6.5m of Worcester Chambers on the existing ground the same as Option A, and transfers the next adjacent 6.5m over the basement, with the intention of reducing the impacts on the functionality and space in the basement that would result from Option B1.

This option is likely to require significant additional work that would include the installation of:

- (a) Heavy transfer beams beneath the existing foundations.
- (b) Additional columns and walls/frames in the basement to support the added gravity weight and seismic mass of the heavyweight superstructure.
- (c) Enhanced ground floor slab and/or steel floor bracing to distribute the increased lateral earthquake loads to the basement walls/frames.

The above-noted additional works will add significant extra cost to the retention of Worcester Chambers, plus there is added risk of causing consequential damage to the Worcester Chambers superstructure during the retention process when compared with Options A and B1.

5.12.2.3 Option B3: 13m Retained Altered Superstructure Part Transferred Over Basement

> This option is the same as Option B2, except that the Worcester Chambers superstructure is altered to reduce its overall weight and reduce the sizes and costs of the transfer beams, columns, walls and enhanced ground floor.





There are numerous variations possible that could involve one or more of the following:

- (a) Remove heavy concrete first floor, and install new steel frames to laterally support the retained walls over their full height to roof level.
- (b) Deconstruct the full superstructure, and reinstate with lightweight roof, walls, floors, frames and brick veneer to match the current aesthetic of the walls (although it is noted that this would impact the historic heritage that this option was seeking to retain.

It is Quoins opinion that the benefits of reducing the overall weight of the superstructure on the transfer beams and structure below ground level are likely to be offset by the added cost of removing the heavyweight structure and installing supplementary steel frames to allow the works to be undertaken.

The costs are likely to be similar or higher than Option B2, depending on the final extent of the works.

5.12.3. **Option C: Full Retention**

The structural requirements to retain the full footprint of Worcester Chambers are similar to Options B1, B2 and B3, except that the footprint of the retention is significantly larger.

The effects on the functionality of the spaces above and below ground are hugely significant, for whichever option is chosen.

From a structural perspective, the basement could be constructed in two sections, each side of Worcester Chambers, and linked together via a tunnel (or tunnels – one in each direction). This would at least require transfer beams and slab beneath the foundations of Worcester Chambers to act as a roof to the tunnel(s).

It is Quoin's opinion that any option to retain the full footprint of Worcester Chambers would result in a significant compromise to the functionality of the ground floor spaces, and a combination of significant additional costs and/or compromise to the functionality of the basement space.





6. Statutory Regulations Concerning Existing & Earthquake-Prone Buildings

This section highlights statutory requirements concerning existing and earthquakeprone buildings as laid out in the Building Act 2004, Building Code, and the Christchurch City Council's Earthquake-prone Building Policy 2010.

6.1. Building Act Requirements

The Building Act 2004 came into force on 31 March 2005 along with the Building Regulations. In considering the structure of existing buildings the relevant sections of the Act are as follows:

Section 124 – Powers of territorial authorities in respect of dangerous, earthquakeprone, or insanitary buildings.

If the Territorial authority is satisfied that a building is dangerous or earthquake prone, the Territorial Authority may:

- (a) Put up a hoarding or fence to prevent people approaching the building;
- (b) Place a notice on the building warning people not to approach the building; or
- (c) Give written notice requiring work to be carried out on the building to reduce or remove the danger.

Section 122 - Meaning of earthquake-prone building

This section of the Act deems a building earthquake prone if its ultimate strength capacity would be exceeded, and the building would be likely to collapse causing injury or death, in a "moderate earthquake". The size of a "moderate earthquake" is defined in the Building Regulations as one third the size of the earthquake used to design a new building at that site.

Section 112 – Alterations to Existing Buildings

This section requires that after any alterations, the building shall continue to comply with the structural provisions of the Building Code to at least the same extent as before the alteration. This means that alteration work cannot weaken the building. Additional building strength would therefore be required where structural elements are to be removed or weakened, or additional mass to be added. The building will also need to be assessed in terms of the egress from fire, and access for persons with disabilities provisions of the Building Code and upgraded to comply, as nearly as is reasonably practicable.

Section 67- Waivers and Modifications

This section allows the Territorial Authority to grant a Building Consent subject to waivers or modifications of the Building Code. The Territorial Authority may impose any conditions they deem appropriate with respect to the waivers or modifications.





The Building Act was also altered by the Canterbury Earthquake (Building Act) Order 2010, which, amongst other things, gave additional powers to the Territorial Authorities, extended the definition of a dangerous building and extended the Schedule 1 list of building work exempt from Building Consent.

6.2. Christchurch City Council Requirements for Earthquake-Prone Buildings

The Christchurch City Council adopted a new policy for earthquake-prone buildings in September 2010.

The policy reflects the Christchurch City Council's determination to reduce earthquake risk to buildings and ensure that Christchurch "is a safe and healthy place to live in" and may be viewed on the CCC website.

In summary, the relevant items of the policy are as follows:

- (a) Buildings are assessed using the New Zealand Society of Earthquake Engineering (NZSEE) guidelines with applied loadings from AS/NZS 1170.5 and are classed as earthquake prone if its strength is less than 33% of the applied loading from the loading standard AS/NZS 1170.5.
- (b) It outlines the Council's approach to earthquake-prone buildings including identification, prioritisation, timeframes and implementation. In general, Importance Level 4 buildings (Postdisaster facilities, as defined by AS/NZS1170) will have 15 years from 1 July 2012 to either be strengthened or demolished. Importance Level 3 (crowd or high value) buildings will have 20 years and Importance Level 2 (normal) buildings will have 30 years. There are also additional triggers for requiring assessment and strengthening work to be undertaken at an earlier stage (including "significant" alterations or earthquake damage).
- (c) The Council has a commitment to maintaining the intrinsic heritage values of Heritage buildings and has some discretion with regards to strengthening levels and methods. Each building will require discussion with Council Heritage team and Resource Consent prior to any strengthening or repair works being undertaken.

To date the Council has identified 67% of New Building Standard (NBS), or current Code, as the target level for strengthening of earthquake-prone buildings. However, the actual level of strengthening for each building can be agreed between the Council, the building owner and their insurer between the levels of 33% and 67% of current code, taking into account the following:

- The cost of strengthening
- Building use
- Level of danger presented by the building
- How much the building has been damaged



For buildings with a damaged building strength >33% of current code, it is recommended (but not required) that the building also be strengthened.



6.3. Recent Seismicity Changes for Christchurch

As a result of new information from the recent Canterbury earthquakes, changes have been made to Section B1 of the Building Code, increasing seismic code levels within areas covered by the Christchurch City, Selwyn District and Waimakariri District Councils. Such changes include:

- Increasing the zone hazard factor (Z) in AS/NZS1170.5 from 0.22 to 0.3, and serviceability limit state risk factor (R_s) from 1.25 to 1.33.
- Replacing Section 5 of NZS3604:1999 with NZS3604:2011 Section 5, adopting Earthquake Zone 2.

These changes came into effect on the 19th May 2011 and are interim code levels pending further seismological study and investigation. For further information on other changes refer:

http://www.dbh.govt.nz/information-sheet-seismicity-changes.

If you have any queries regarding the above Structural Assessment Report, please do not hesitate to contact the undersigned.

Yours sincerely Quoin Structural Consultants Limited

Ba Gilmore.

Brett Gilmore B.Eng (Hons)(Civil) Senior Structural Engineer & Director MIPENZ; CPEng (# 139988) PE (USA), Int PE





Appendix A: Existing Building Plans & Drawings

Harley Chambers

Existing Drawings

- 1.1 Main Building Plans (Scale 1:200 @ A4)
 - SK00 Existing Ground Floor Plan
 - SK01 Existing First Floor Plan
 - SK02 Existing Second Floor Plan
- **1.2** North Section (Scale 1:100 @ A3)
 - SK1 Existing Ground Floor Plan
 - SK2 Existing First Floor Plan
 - SK3 Existing Second Floor Plan
 - SK4 Existing Basement & Sections A-B
 - SK5 Existing Basement & Sections E-F
 - SK6 Existing Typical Floor Beam & Stair Details











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Appendix B: Summary of Earthquake Damage to North Section of Building

Harley Chambers











Photo			
Repair Option(s)	 Epoxy resin injection to reinstate Recommend remove & replace 	 Epoxy resin injection to reinstate Recommend remove & replace 	Epoxy injection
Earthquake Damage	Crack in masonry block wall	Crack in masonry block wall	Cracks in concrete suspended floor
Location	7-Wall R1	8-Wall C1	9-Floor





Photo		
Repair Option(s)	 Break out part sections of the main structural walls, floors and parapets, and reinstate with new tie connections with epoxied reinforcing 	 Remove brick wall and replace with new reinforced concrete wall over full height & width of building for both walls B1 & B2
Earthquake Damage	Junction between the north & south building sections has opened up over the full height & width of the building	Crack in brick wall & finishes
Location	10-Junction of north & south building sections	11-Wall B2





Photo		
Repair Option(s)	 Reconstruct the lift shaft walls as new reinforced concrete down to 2nd floor level as part of the repair to reinstate Recommend that consideration to reconstruct walls down to ground level as part of overall repair 	 Provide additional lateral support to parapets or remove and replace
Earthquake Damage	The top portion of the lift shaft above roof level comprises of brick wall construction with a concrete slab roof. The walls were severely damaged above roof level and have been removed. The walls were temporarily secured following the 26 December 2010 earthquake. Some cracks observed in the walls to the lift shaft below roof level.	Some cracks noted at base of parapet to exterior of north-east corner along east elevation of south section of building
Location	12-Lift Shaft	13-Parapets





Photo				
Repair Required	Reinstate joint	Re-level affected area of floor	 Epoxy injection and consider application of waterproof tanking to inside face of walls and floor 	
Earthquake Damage	Expansion joint between Harley Chambers & the adjacent north building needs to be inspected in detail.	Floor is out of level at ground floor indicating that some settlement of the foundations has occurred.	Several cracks noted in the basement walls with water ingress through cracks due to new spring	Structex have not inspected the non-structural elements in any detail. These include but are not limited to: • wall/floor/ceiling finishes • windows and doors • services/electrical/mechanical, water, power etc
Location	14-Expansion joint to north boundary & building	15-Floor at north east corner	16-Basement	17-Non-structural elements





Appendix C: Floor Level Survey & Wall Investigations

Harley Chambers

Sketches

- SK08 Floor Levels on Existing Ground Floor
- SK09 Floor Levels on Existing First Floor
- SK10 Existing Ground Floor Plan North Building Wall Information





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Wall type	Overall Thickness (mm)	Material
W1	350	120 brick + 110 cavity + 120 brick
W2	130	hollow masonry block
W3	127	solid reinforced concrete
W4	230	solid reinforced concrete
W5	305	solid reinforced concrete
W6	200	solid reinforced concrete

Column type	Dimensions (mm)	Material
C1	1600 x 660	reinforced concrete
C2	1200 x 660	reinforced concrete
C3	600 x 330	reinforced concrete

Wall types, thicknesses and materials continued by nuestigation with Bess Construction



Existing Ground Floor Plan		Project
North Building Wall Information	SKIO	10490
North Building - Wall Information		0
Drawing Title	Drawing No.	Issue



Appendix D: Earthquake Repairs Summary Table

Harley Chambers



HARLEY CHAMBERS - EARTHQUAKE DAMAGE AND REPAIRS

Item No	Earthquake Damage	Earthquake Repair Strategy
1	Earthquake Damage - Structural	Comments
101	Cracks in basement walls, resulting in leaking and pooling of approx 400-600mm of water.	Basement to be demolished, removed and reconstructed. This strategy is the only strate condition. Our recent experience with similar damaged basements is that Contractors ar reconstructed. Refer supplementary notes on sketch SKR11 for reconstruction methodo
102	North Section settlement of foundations, resulting in foundations and timber ground floor framing not being level. Levels vary 82mm across the North Section footprint.	Allow for underpinning and jacking of foundations using steel screw piles to approximate area of basement - refer Item 101. Interior piles supporting timber floor only and strip for confirm extent by sketches. Refer sketch SKR1 and attached screw pile information. All beneath 90sm of foundation. Refer sketch SKR21 for methodology. Sketch SKR1 update beam.
103	South Section settlement of foundations, resulting in foundations timber ground floor framing not being level. Levels vary 52mm across the South Section footprint	Allow for underpinning and jacking of foundations using steel screw piles. Lesser numbe supporting timber floor only to be reconstructed. Quoin to confirm extent by sketches. information. Allow for 8 piles to be jacking piles, plus allow to grout 30mm beneath 40s
104	Cracks in concrete floor slab at ground floor over basement	This slab removed and reconstructed as part of basement reconstruction.
105	Cracks in interior masonry Bell block partition walls - North Wing	Remove all block partition infill walls. Reinstate with 140mm masonry block, solid filled, 1000mm lg, 200mm into all adjacent columns, beams, floors and foundations. Refer to Allow to construct 50m of 150mm wide x 350mm deep rib in 0.6m long sections within a block walls that do not align with existing floor ribs. Refer to sketch SKR20.
106	Cracks in interior concrete partition walls - South Wing. Refer to attached sketches SKR14/R15 and R16 for general extent.	Epoxy inject cracks. Allow for 100 lineal metres.
107	Cracks in interior double brick walls along interior wall line between North and South Wings	Remove brick infill. Reinstate with 240mm masonry block, solid filled, reinforced with H2 into all adjacent columns and beams. New block infill constructed over new basement v
108	Cracks in concrete shear wall at north side of entry lobby in North Wing.	This wall removed and reconstructed as part of basement reconstruction. Refer sketch
109	Cracks in exterior plastered double brick walls - North Wing	Remove brick infill as shown on sketches. Reinstate with 240mm masonry block, solid fil 1000mm lg, 200mm into all adjacent columns, beams, floors and foundations. Refer to to include repairs to brick walls (BWR) using Helifix ties, plus epoxy injection, plus remove
110	Cracks in exterior plastered double brick walls - South Wing	Investigation confirmed that exterior cracks do not generally penetrate the bricks. Some the second floor level. Allow to remove and replace 5.0m of brick wall beneath four win
111	Cracks in concrete exterior beams and columns to entire North Elevation of North Wing. These beams and columns extensively cracked compared to most other beams and columns.	Investigations confirmed that cracks do not appear to penetrate into the beams and colu damage. Recommend reconstruct between foundation and first floor beam. Refer sket
112	Cracks in plastered concrete columns (exterior) - North Wing (excludes Item 111 above).	Epoxy inject cracks. Investigations confirmed that cracks in plaster do not appear to per concrete to be epoxy injected (25m).
113	Cracks in plastered concrete beams (exterior) - North Wing (excluding Item 110 above)	Epoxy inject cracks. Investigations confirmed that cracks in plaster do not appear to per concrete to be epoxy injected (25m).
114	Cracks in plastered concrete columns (exterior) - South - Wing	Epoxy inject cracks. Investigations confirmed that cracks in plaster do not appear to per concrete to be epoxy injected (25m).
115	Cracks in plastered concrete beams (exterior) - South - Wing	Epoxy inject cracks. Investigations confirmed that cracks in plaster do not appear to per concrete to be epoxy injected (25m).
116	Cracks in concrete floors - Refer to attached sketches SKR15 and SKR16 for extent of cracks observed in rooms where carpets lifted.	Epoxy inject cracks. Estimate 180m at first floor level, and 340m at second floor level. Searthquakes. The extent of cracks reduces the strength of the floor to act as a diaphrage
117	Cracks and damage to North double brick parapet wall directly adjacent to boundary (removed as part of partial S38 works)	Reinstate with 240mm masonry block, solid filled, reinforced with H12@400 ew. Drill + o column piers and beams. 240 block is closest 'like for like'. Refer to sketch SKR4.
118	Cracks and damage to double brick parapet walls - North Wing	Reinstate with 240mm masonry block, solid filled, reinforced with H12@400 ew. Drill + column piers and beams. 240 block is closest 'like for like'. Refer to sketch SKR4. Sketc of parapet and form concrete bond beam with epoxied bars.
119	Cracks and damage to double brick parapet walls - South Wing	Damage to parapets not as extensive as north wing. Allow to repair 2 bays of parapet th
120	Cracks to plastered concrete parapet walls - North Wing - Cambridge Tce frontage	Epoxy inject cracks. Allow for 20m.
121	Cracks to plastered concrete parapet walls - South Wing - Cambridge Tce and Worcester Boulevard frontages	Epoxy inject cracks. Allow for 20m.

Comments

egy that repairs the basement to its pre-earthquake watertight re unable to provide guarantees for water tightness unless ology, and sketches SKR5 - SK10 inclusive.

ely 3.5m depth below ground level. Note that this excludes ootings to Bell Block walls to be reconstructed. Quoin to low for 40 piles to be jacking piles, plus allow to grout 50mm ed to substitute 310 UC's for 500 x 500 concrete underpinning

er of jacking piles required than North Section. Interior piles Refer attached sketch SKR12 and attached screw pile sm of foundation. Refer to sketch SKR21 for methodology.

reinforced with H12@400 ew. Drill + epoxy H12 starters, sketches SKR2/R3 and R4. existing first and second floors to accommodate starters for

12@400 ew. Drill + epoxy H12 starters, 1000mm lg, 200mm wall. Refer sketches SKR2/R3 and R4.

SKR2.

lled, reinforced with H12@400 ew. Drill + epoxy H12 starters, sketches SKR2/R3 and R4. Sketches SKR2/R3 and R4 updated val and reinstatement of interior 25mm plaster.

e damage was noted in brick walls to the south-east corner of ndows in the south section, similar to Item 109.

umns. Two concrete columns at the ground floor level have tch SKR2.

netrate the concrete. Assume a nominal amount of cracks in

netrate the concrete. Assume a nominal amount of cracks in

netrate the concrete. Assume a nominal amount of cracks in

netrate the concrete. Assume a nominal amount of cracks in

Some cracks appear old and some appear new caused by m.

epoxy H12 starters, 1000mm lg, 200mm into all adjacent

epoxy H12 starters, 1000mm lg, 200mm into all adjacent ch SKR4 updated to include repair comprising of cut-down top

ne same as Item 118 with formed concrete bond beam.

122	Spalling and/or separation of vertical joint between North and South wings - East End	Ensure that North and South Sections are well tied together. Quoin to propose details. R
123	Spalling and/or separation of vertical joint between North and South wings - West End	Ensure that North and South Sections are well tied together. Quoin to propose details. R
124	Separation of floor and roof joints between North and South wings.	Ensure that North and South Sections are well tied together. Quoin to propose details. R
125	Cracks and damage to double brick walls to lift shaft above roof level (removed as part of emergency safety works)	Reinstate with 270mm (average thickness) reinforced concrete wall, reinforced with H12
126	Cracks to double brick walls to lift shaft between Level 2 to roof level	Demolish this section of lift shaft walls to allow reconstruction of walls above per Items 1 reinforced with H12@300 ew, ef. Drill + epoxy H12 starters at 400crs, 1000mm lg, 200m
127	Cracks to concrete walls to lift shaft between Foundation level and Level 2	Demolish lift shaft and reconstruct as part of basement reconstruction. Refer to sketche
128	Roof slab to lift shaft (previously removed as part of emergency works).	Reinstate as 150mm thick insitu concrete slab, reinforced with H12@250crs ew, and tie i battens over slab. Install new 200UB30 lifting beam.
129	Cracks in soffit to main stairs at top of each flight (concrete)	Epoxy inject cracks and install steel plates per Endel Lust scope. Refer to sketch SKR19.
130	Temporary gravity propping to allow repair works to be undertaken (Items 101,105, and 111).	Significant propping required to North Section. Stx to describe in further detail. Allow to centres x 250m spread over three floors.
131	Temporary lateral propping (steel braces) to allow repair works to be undertaken for North Section.	Significant propping required to North Section. Bell block walls and lift shaft walls provid reconstructed. Recommend allow to provide the following steel braces with 20mm "L" e 6-200 x 6 SHS x 8.5m long 18-150 x 6 SHS x 6.7m long 24-150 x 6 SHS x 4.6m long
2	Earthquake Damage - Non-Structural	Comments
201	Cracks to ceiling finishes - North Wing	Allow to remove all ceilings and reinstate. This also allows full assessment of floors and repairs to floor where required.
202	Cracks to ceiling finishes - South Wing	Allow to remove all ceilings and reinstate. This also allows full assessment of floors and repairs to floor where required.
203	Cracks to interior light weight wall finishes not noted in other items - North Wing	Allow to remove all wall finishes and reinstate.
204	Cracks to interior light weight wall finishes not noted in other items - South Wing	Allow to remove all wall finishes and reinstate.
205	Cracks to exterior plaster finishes	Remove damaged sections as part of Items 112, 113, 114, 115, 118, 119, 120, 121 and re The north elevation is worst affected and recommend remove all plaster to beams and c
206	Broken windows	Replace as required. This will require use of Flemish glass in many of the locations.
207	Broken windows in office doors as part of earthquake emergency services	Replace as required. This will require use of Flemish glass in many of the locations.
208	Damage to expansion joint flashings between Harley Chambers and building at North Boundary	Noted that there is now a new building adjacent to the boundary with Harley. Allow for r
209	Jammed and/or misaligned interior and exterior doors	Remove/reinstall as required to suit damage and repairs to other elements. Remove ten temporary removal of all doors.
210	Movement gaps/cracks to interior finishes(architraves, skirtings, etc)	Remove/replace as required to suit damage and repairs to other elements.
211	Removal and reinstatement of all interior floor finishes. Floor finishes suffered extensive damage (pigeon droppings, ingress of moisture, etc)	Removal also allows full assessment of floors, plus repairs to masonry block partition wal
212	Check metal roof cladding to North wing. Allow for disruption for repairs.	As noted. This will require removal and reinstatement to all perimeter sections adjacent damaged areas. Refer repair items 118, 119, 125.
213	Remedial works to roof membrane as part of repairs to parapets and tied joint between North and South Sections. (Items 118/119 and 122/123/124)	As noted.
3	Structural Repairs for 34% x NBS - Additional to Above	Comments
301	Floor slab edges remedial works to ensure adequate tie between perimeter beams and infill masonry block walls and floor diaphragms	Stx to review
302	Floor slab remedial works to ensure adequate tie between interior masonry block walls and floor diaphragms	Stx to review
303	Check floor slabs for adequate diaphragm capacity.	Stx to review
304	Allow to install glass panels to sides of main access stair to achieve compliance as part of Building Consent.	As noted.
305	Allow to install accessible toilets on the ground floor level to achieve compliance for Building Consent. Likely involve alterations to existing partition walls and plumbing etc.	As noted.

Refer to sketches SKR17 and SKR18. Fill joint gaps with grout.

Refer to sketches SKR17 and SKR18. Fill joint gaps with grout.

Refer to sketches SKR17 and SKR18. Fill joint gaps with grout.

2@300 ew, ef. Refer sketch SKR9.

125 and 101. Reinstate with 270mm (average thickness) wall, mm into existing floors. Refer to sketch SKR9.

es SKR1/R2/R3/R4 and R9.

into shaft walls. Reinstate light roof cladding on timber

o provide average of 2 x 3T acrow props spaced at 1.0m

ide main lateral resistance and these are to be removed and end plates and 8 x M16 epoxied bolts per end plate.

repairs to masonry block partitions to be undertaken, plus

repairs to masonry block partitions to be undertaken, plus

reinstate. Allow for 350m to east, south and west elevations. columns and reinstate (170sm).

new joint flashings as required.

mporary store as part of repairs. Refer to Item 405 for

alls, and cracks in floors.

t parapet and lift shaft repairs and reconstruction. Replace any



Appendix E: North Section Repair Sketches

Harley Chambers

North Section Repair Sketches (Scale 1:100 @ A3)

- SKR1 Pile Underpinning & Foundation Plan
- SKR2 Ground Floor Plan
- SKR3 First Floor Plan
- SKR4 Second Floor Plan
- SKR5 Basement Reconstruction Plan & Section A-B
- SKR6 Basement Reconstruction Section E-F
- SKR7 Ground Floor Plan Temporary Transfer Truss & Beams
- SKR8 Temporary Transfer Section E-F
- SKR9 Temporary Transfer Truss & Beams Section C-D
- SKR10 Temporary Beams to Support Stair & South Wall Section A-B
- SKR11 Basement Reconstruction Methodology
- SKR12 Cracks in Walls to Lift Shaft (A4 Sketch for reference)
- SKR19 Repairs to Main Stairs
- SKR20 Floor Details for New Block Partition Wall





NOTES





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Project Title

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NOTES 1. Reter to SK.R.2 for Notes.

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Z	South Wall - Section A-B	-200	O
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Basement Reconstruction Methodology

Item 101

- (a) A number of strategies to repair the leaks in the basement have been considered, including the epoxy injection of cracks in the walls and floor slab together with the use of moisture resistant products to the inside faces of walls and floor. However, these methods do not return the basement to its pre-earthquake condition and further leaks are possible. These methods are not guaranteed by the contractor and/or waterproofing specialists.
- (b) The Basement is to be demolished, removed and reconstructed. This includes the foundation slab and walls, and suspended concrete floor at Ground floor level that extends over the basement. This strategy ensures that the basement is repaired to its per-earthquake water-tight condition.
- (c) The reconstruction of the basement will involve the following (refer to Sketches SKR5 to SKR10 inclusive):
 - (i) Install temporary steel transfer truss, beams, and foundations/piles to redistribute the column loads and weight of the existing stair outside of basement footprint.
 - (j) Remove existing Bell block infill walls and brick infill walls above the basement area as required.
 - (ii) Localised dewatering.
 - (iii) Removal of the suspended concrete floor over the basement at ground floor level.
 - (iv) Install temporary lateral braces the main columns.
 - (v) Removal of basement walls and foundation slab.
 - (vi) Excavate approximately 800mm depth beneath the level of the existing base slab to match the base level of the existing deep foundation pads that are to remain.
 - (vii) Underpin existing east side foundation adjacent to the basement.
 - (viii) Install temporary retaining. Allow for 100mm thick reinforcing Shotcrete wall to steep battered slopes with ground anchor ties as required.
 - (ix) Lay 750mm compacted hardfill in 200mm maximum layers over base of excavation.
 - (x) Place 50mm site concrete.
 - (xi) Lay tanking membrane.
 - (xii) Construct 400mm thick base slab, reinforced with H20 @250mm each way, top and bottom. Cast in waterstops at wall junctions. Use 40MPa concrete with Sika 1 waterproof additive.
 - (xiii) Construct 250/300mm thick walls, reinforced with H16 @ 200mm each way, each face. Use 40MPa concrete with Sika 1
 - (xiv) Construct columns integral with walls, similar to existing. Install 200 x 9 steel SHS interior columns in lieu of 200mm x 200mm concrete columns. Fire rate for 60 minutes.
 - (xv) Install tanking to rear face of walls.
 - (xvi) Construct reinforced concrete steps, lower flight and internal walls.
 - (xvii) Backfill as required with compacted hardfill.
 - (xviii) Reconstruct suspended concrete slab and beams over the basement.

project	HARLEY	CHAMBERS	date	15-6-15		Q uoin
file	12088		by	BAG	ref	SKR12



NORTH

(

WEST

SOUTH

· LIFT SHAFT WALLS - CRACKS LINSIDE FACE) · East wall not accessible

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Also refer to Hom 304 for allowance to install glass panels to sides of stairs to achieve compliance for building Consent.





Appendix F: South Section Repair Sketches

Harley Chambers

South Section Repairs Sketches (Scale 1:200 @ A4)

- SKR13 Pile Underpinning & Foundation Plan
- SKR14 Ground Floor Plan Cracks in Concrete Walls and Columns









Appendix G: Building General Repairs

Harley Chambers

Repairs - General

- SKR15 First Floor Plan Cracks in Concrete Floors and Walls
- SKR16 Second Floor Cracks in Concrete Floors and Walls
- SKR17 Floor and Wall Joint Repair to North-South Sections
- SKR18 Floor and Wall Joint Repair to North-South Sections
- SKR21 Relevelling Methodology
- SKR22 Relevelling and Underpinning Plan
- SKR22A Relevelling and Underpinning Plan
- SKR23 Relevelling and Underpinning Details
- SKR24 Relevelling and Underpinning Details
- SP1-SP11 Steel Screw Pile Information






project HARLEY CHAMBERS	date 214-7-2015)uoin
file 12088	by BAE-	ref SERI7	
Items 122, 123, 124			
Agreed general score of	- repairs to the -	the North & Sout	sh
sections together, simila	ir to Endel Lust	SCOPE	
March 2013 as follow	s'.		

(iv) Remove loose plaster bricks etc in vertical separation gaps between North & South buildings. Connection detail between the two will require more detailed investigation and design. For pricing purposes a suggested connection system is to use 150 x 150 x 10 steel angles or 300 x 10mm steel flats, each 300mm long with 4 - 18mm dia holes for M16 bolts to be epoxy fixed into either side of the gap, that is into either building half. It is estimated three such connections at each wall join for each floor plus at least two such joins into the parapets. That is approx 40 such connections in total.

Endel Lust

above proposed repairs : (a) Use 300×10mm steel thats, each <u>FOOmm</u> long. The

> additional length is to ensure suitable edge distance to the bolts, plus have 4 bolts each side of joint



project	HARLEY CHAMBERS	date	24-7-2015		Quoin
file	12088	Ьу	btte	ref	SKRI 8

- (b) Bolts to be epoxied 200mm into concrete beams and columns. Use Hilti RE500. At locations where bolts coincide with the floor stabs and not the beam, extend bolt through stats and provide 30×80×6 washer and nut
- (c) Allow to recess the sheel plates into the concrete and have top of bolts flush with theor slabs or column/beam face. Recess approximately 30mm, typical, Growt fill recess.
- (d) Further to (b) & (c) above, estimate that have: 16 into columns (including parapet piers) 24 at edge beam / floor slab
- (e) Allow to remove and remotete roof cladding and membrane, and remotate at roof level.
- (f) The following copy of lan Harrison & Assoc estimate to be updated for the above Quoin adjustments

Junction of North and South Wings							
300 x 300 x 10mm plates bolted with M16	40.00	no	224.00	2.40	96.00	56.00	14,336.00
Allow to epoxy inject gap between concrete	44.00	m	400.00	1.00	44.00		20,064.00
Allow for plaster repairs both sides of	44.00	m	180.00				7,920.00
junction							

Relevelling Methodology (Draft)

SKR 21

The draft methodology for the re-levelling works is as follows:

- 1. Strip out ground floor area.
- 2. Disconnect/cap-off services.
- 3. Remove ground floor framing adjacent to foundations.
- 4. Carry out level survey.
- 5. Install piles.
- 6. Rib the piles with 5mm fillet weld in rings around the circumference of the pile over the foundation depth at 200mm pitch.
- 7. Construct new foundations ensuring:
 - (a) endplate and threaded rods associated with jacking detail are cast in.
 - (b) piles wrapped in 10-15mm of polystyrene.
 - (c) pockets left at pile locations for re-levelling.
 - (d) reinforcing and starters to existing structure are provided as specified.
 - (e) engineer inspects prior to casting concrete.
- 8. Place transducers to measure displacement and re-level building utilising an 8 zone synchronous lift system. Each zone is to be 6.0m long, where the maximum amount of total lift is required. The re-levelling process is as follows:
 - (a) Ensure all zones are primed 0.25mm at a time until movement is shown on the system transducers. It is critical to ensure that the building is 'free' from ground suction at all locations.
 - (b) Raise Zone 1, 1mm at a time. Hold the structure at each millimetre to allow ground resistance to dissipate. Continue to lift Zone 1 until a pressure drop is recorded in Zone 2 or the maximum allowable lift per any one zone is reached. The maximum single lift value is 25mm.
 - (c) Raise Zone 2 until the load is shared between Zones 1 and 2, or the 'maximum single lift value' is reached.
 - (d) Raise Zones 1 and 2 as per points 8b and 8c until a pressure drop is recorded in Zone 3 or the 'maximum single lift value' is reached.
 - (e) Zone 3 is then included in the lifting sequence above and the procedure is continued until all zones are in the sequence.
- 9. Provide engineer with final levels of the building foundations for review and approval.
- 10. Grout fill beneath re-levelled foundations.



PliProjects WorkflowMax (12033)/C\Harley Chambers\Sketch SKR21 docx

- 11. Trim piles that protrude past the top of the foundation beams. Remove top plate of jacking system and trim threaded rods which protrude past the top of the foundation beams.
- 12. Burn out polystyrene from around the piles and fill with high strength grout.
- 13. Grout up jacking recess.
- 14. Reconnect services.
- 15. Repair and make good in the remainder of the building following a detailed dilapidation survey.

Revisions to the proposed methodology may be provided subject to the engineers review and approval.

















TYPICAL JACKING DETAILS







SP5

Brett Gilmore

From: Sent: To: Subject: Attachments:

Glen Budden [Piletech] <GlenB@piletech.co.nz> Tuesday, 21 July 2015 5:45 p.m. Brett Gilmore RE: Structex query 15-07-21 pile capacity vs rig size chch GAB.pdf

Hi Brett,

Further to our discussion please find attached access requirements versus achievable pile capacities for piles founding in the intermediate gravels in Christchurch. Note that these values should be used as an indication only as capacities will be dependent on the site specific geotechnical information which does vary considerably in CHCH.

Cheers Glen

Glen Budden Samor Design Bingmeier - Pileteign

The Flatcher Construction Company Ltd trading its Piletech 15 Ditigety Oniver Wint – Pio Box 97250, Manukau 2241 Ph. 19 239, 1503, Mobi: 321, 234, 4176, Email: <u>GlenBudden@piletech.co.nz</u>

PRIDE OF PLACE: www.piletech.co.nz

Think GREEN before choosing to print this email

From: Brett Gilmore [mailto:BGilmore@structex.co.nz] Sent: Tuesday, 21 July 2015 5:03 p.m. To: Glen Budden [Piletech] Subject: Structex query

Hi Glenn.

Good to talk to you. This to confirm my email.

cheers

Brett Gilmore (CPEng) bgilmore@structex.co.nz

structex

Structex Metro Limited, Level 1, 575 Colombo Street PO Box 25438, Christchurch, New Zealand Tel: +64 3 968 4925, Fax: +64 3 968 4927, Mobile 021 435 525

This email has been filtered by SMX. For more information visit smxemail.com



SP6

Compressive Load Capacity in Cohesionless Soils



SP7



SP8









Appendix H: Concepts for Strengthening

Harley Chambers

General

- SK13 Ground Floor Plan Eastern Concrete Walls
- SK14 First Floor Plan Eastern Concrete Walls
- SK15 Second Floor Plan Eastern Concrete Walls

34% x NBS

• SK11 Ground Floor Plan North Section

67% x NBS

• SK16 Ground/First/Second Floors New Skin Walls to South Section

100% x NBS

•	SK12	Ground Floor Plan North Section
---	------	---------------------------------

• SK17 Ground/First/Second Floors New Skin Walls to South Section

Perimeter Column Strengthening to Façade

• SK18 Perimeter Column Strengthening











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Issue		Ву	Appd.	Date	Drawn	Designed	Approved	Scales	Client	Project Title		

Notes

1. Renove all hollow masonry black partition walls and reinstate with 190 solid filled masing block, reinforced, at locations where the walls align above/below floors. Elsenhere, replace with light weight non-stouctural walls. This occurs at all floors,

- 2. Remove double bick walls over full height and reinstate with 240 solid filled masoning block, reinforced.
- 3. Leter to SKID for extent of hollow brick partition walls.
- 4. Proude new reinforced concrete lift shaft walls above Level 2 floor.
- 5. Decembract concrebe wall and revisibile with new 200 mm the concrete wall







			T					[1	03 040 403 5
-				-	BG	BG	BG	1:100	Lee Pee Limited	Harley Chambers	Ounin	03 968 4925
0	Preliminary Information	BG		23/09/2011	1					Harley endineers		quoin.co.nz
Issue		By	Appd.	Date	Drawn	Designed	Approved	Scales	Client	Project Title		

Notes :

Jaun

1. Provide new 300mm the reinforced concrete shear wall at locations shown, full height of building, unless noted otherwise

2. Provide new 400 mm the insitu concrete trane columns + beams

3. Reconstruct lift core walks as new, including lift pd

- 4. Provide new foundations for the above as shown dotted, Allow for 1000mm deep, typ.
- 5. Provide enhanced floor diaphragm ties as shown (reinforcing epoxied into chases in floor stabs and/or carbon fibre reinforced polymer strips (CFRP)

6. A strengthening scheme for 67% × NBS is similar to 100% × NBS accept that reinforcing, may be reduced by 30% and foundation depth reduced by 20%, Some wall thicknesses may be reduced.

7. Strengthening option(s) require further detailed investigation, isureus of analysis and design,

8. Lemove all hollow masuray block purtition walls and replace with light weight non structural partitions.



	Project
SK12	10490
	0
Drawing No.	Issue





Project	HARVEY LITAM	bers.		
Reference	12088 - SK18			
Date	31-7-17	Author	BAG	







PERIMETER COLUMN STRENGTHENING



Appendix I: Façade Retention

Harley Chambers

General

• SKF1 Temporary Steel Frame Lateral Support for Harley Chambers Façade.





Q Quoin

03 968 4925 quoin.co.nz



Cambridge-Worcester Hotel Development

Contents

- 1. Site Address & Consent
- 2. Contact Details
- 3. Responsibilities
- 4. Time Frame
- 5. Description of Work Activities
- 6. Site Inspections
- 7. Noise, Dust & Vibration
- 8. Complaint Protocol
- 9. Notice Board
- 10. Access to Site
- 11. Site Maintenance
- 12. Contractors Facilities
- 13. Sediment Control
- 14. Traffic Management
- 15. Health & Safety

Appendix A Resource Consent Appendix B Indicative Programme of Works Appendix C Health & Safety Plan Appendix D Traffic Management Plan (TMP) Appendix E Sediment Control Plan





1. Site Address & Consent

The site is located at the corner of Cambridge Terrace and Worcester Boulevard, Christchurch, and includes the sites at 137 Cambridge Terrace, 69 Worcester Boulevard and 65-67 Worcester Boulevard.

Resource Consent [RMA] has been issued by the Christchurch City Council for the redevelopment of the site.

The conditions of Resource Consent [RMA] are to be complied with at all times by the contractor. A copy of the Resource Consent is included as Appendix A to the Construction Management Plan [CMP]

2. Contact Details

The Contractor is	
The Site Manager is	
Contact phone number is	
After hours contact number is	

3. Responsibilities

The site manager is responsible for the implementation of this CMP.

The engineer to the contract is [TBC] who will have an overseeing role for ensuring the site manager complies with the CMP, health and safety policy and procedures, engineering design and all regulatory consents.

4. Time Frame

The project will be undertaken in stages over a period of approx. 2.5 years. A preliminary programme is attached [TBC by contractor].

5. Description of Work Activities

- (a) The project works includes the construction of a new hotel adjacent to the Worcester Chambers building as indicated on the Concept Architectural drawings. The hotel includes the construction of the underground carpark, and low height glazed atrium directly adjacent to the east, north and west sides of Worcester Chambers. A brief description of the main works is set out as follows.
- (b) Carefully deconstruct Harley Chambers and rear section of Worcester Chambers
- (c) Install a permanent ground retention system around the perimeter of the Worcester Chambers building and overall site to allow construction of the basement. This would likely involve the following, subject to detailed design:



• Retention system likely to be installed approximately 0.6m-1.0m away from Worcester Chambers.



- Steel sheet piling using low vibration equipment.
- Install near horizontal ties beneath the foundations of Worcester Chambers to tie the top of the sheet pile walls together.
- Part excavate and install horizontal steel walers near the top of the sheet piling, and temporary braces that extend from the walers down to temporary foundations at the level of the new basement.
- Complete full excavation for the basement, construct the foundations, and utilise the steel sheet piling as permanent formwork to construct the concrete walls to the basement.
- (d) Construction of concrete foundations to the basement.
- (e) Tie the foundations of Worcester Chambers to be laterally tied into the new ground floor level slab and beams to the new building as construction of the building(s) proceed.
- (f) The design of the basement structure adjacent to Worcester Chambers to incorporate laterally stiff elements on all sides of Worcester Chambers (eg walls and/or steel braced frames) so that the performance of Worcester Chambers remains unchanged.
- (g) Typically provide seismic joints and gaps between Worcester Chambers and the new building, above ground floor level only. There may be sections of Worcester Chambers where the new building adjoins via flashings, sliding joints, corbels etc.

At times, the work will involve the use of heavy machinery to carry out earthworks and compaction. Heavy machinery is most likely to be utilised at the commencement of the construction period and will likely involve creation of some noise, vibration and dust effects. These effects will be minimised as described in the following sections.

6. Site Inspections

A weekly formal site meeting will occur. Present at the meeting shall be:

- The engineer to the contract and/or his representative
- The contractor,
- Any other personnel considered necessary

The contractor is to keep minutes of the meeting and provide copies to each party by email within 48 hours. The agenda for the meeting will include:

- Those present
- Any apologies
- Work carried out in the previous week
- Review of the programme
- Any quality issues
- Any material supply issues





- Any site instructions required
- Any variations to be issued
- Construction Drawing register update
- Weather conditions over the last week
- Any delays to the work
- Health & Safety Matters
- Council Inspections
- General matters

7. Noise, Dust & Vibration

Where required, machinery is to be muffled so that they comply with the limits for construction noise as set out in the Christchurch City Plan. Construction noise and vibration is to comply with New Zealand Standard NZS 6803:1999 'Acoustics – Construction Noise.

The contractor is to provide the engineer with certification for each heavy machinery and its compliance with the relevant noise limits.

No work is permitted on Sundays or Public Holidays.

The contractor is to have a water cart and/or water sprinkler equipment available during the earthworks activities to be used to supress dust during dry/windy periods.

Vibration from earthworks machinery is to be monitored by the site manager and engineer and if found to be excessive then alternative methods of construction employed. This is to be discussed between the engineer and site manager at the time of the works.

8. Complaint Protocol

A register is to be kept by the site manager of any complaints received from the public or the Council. This register is to be available for viewing by the engineer and the Council.

The site manager is to investigate each complaint made and make recommendation to the engineer on how to rectify the problem. The engineer will then, if necessary, instruct the site manager to undertake the work as appropriate.

If a complaint is received from or via the Council then the site manager is to keep Council and the engineer informed of the rectification measures taken, where required.



9. Notice Board

A notice board is to be erected next to the site entrance. The notice will identify the site manager, telephone number and address of service.

10. Access to Site

Access to site is to be provided off Worcester Boulevard. Due to the nature of the area care is to be taken for the establishment of large equipment and the delivery of bulk materials.

11. Site Maintenance

The site is to be maintained in a tidy state at all times. Any rubbish is to be removed on a weekly basis. Materials are to be stored in tidy stockpiles. The engineer will inspect the site on a weekly basis and will instruct the site manager to rectify any areas of the site that is left untidy.

12. Contractors Facilities

The contractor is to provide a temporary site office on the land next to the site entrance. Port-a-loos are to be provided for the contractor's staff during the works.

13. Sediment Control

A sediment control plan is to be submitted to the engineer for approval and submitted to CCC before construction works commence. The sediment control plan is to follow ECAN Erosion & Sediment Control Guideline 2007.

14. Traffic Management

A traffic Management Plan (TMP) is to be developed by the contractor identifying how material supplies and mechanical plant are to be delivered to site. A copy of the TMP is to be held on site. The TMP is to be submitted for approval by CCC before construction works commence.





15. Health & Safety

The contractor shall comply with enactments, regulations and working rules relating to safety, health and welfare for both workmen and members of the public, and in particular the requirements of the Health and Safety in Employment Act 1992 (The Act), amendments and regulations of 1995, and the requirements of the Occupational Safety and Health Authority (OSH) and as current at the date of the contract.

The contractor will take all practical steps necessary to assist the principal to comply with the provisions of the Act and advise the engineer immediately of any obligations under the act that are not being fulfilled by any party.


Appendix B

Letter to Valour Properties Limited from Structex Metro Ltd – Continuing Concerns Regarding Occupancy, Damage to Building & Construction of New Adjacent Building, dated 10 October 2013



structex metro ltd

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10 October 2103

Dr Gerard McCoy QC SCB & Rosie Hobbs Valour Properties Ltd PO Box 2838 Christchurch 8140

By Email: valourproperties@xtra.co.nz

Dear Gerard & Rosie

Re: Harley Chambers Building, 137 Cambridge Terrace, Christchurch Continuing Concerns Regarding Occupancy, Damage to Building & Construction of New Adjacent Building

1. Introduction

As requested, Structex Metro Limited have completed an inspection of the exterior of the Harley Chambers Building with the main aim of providing further advice to you on its current structural condition, damage, and safety of the building relative to the people around it.

This follows the letter received from CERA dated 27 September 2013 regarding continuing concerns regarding occupancy and safety of the building, and the letter received from Aurecon dated 8 October 2013 that expresses significant concerns about the north wall of the Harley Chambers Building that is located directly adjacent to the new building that is to be constructed at 141 Cambridge Terrace.

The following is a summary of our recent observations and assessment of the building and response to the letters received from both CERA and Aurecon.

This letter/report assumes that the readers are familiar with the form of construction of the building and the assessments and reports completed to date. Copies of the above noted letters from CERA and Aurecon are attached, plus a copy of the Detailed Engineering Evaluation Report completed by Structex Metro Limited dated 8 November 2011.



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2. Inspection Completed by Structex Metro Limited

Structex Metro Limited completed our recent inspection of the Harley Chambers Building on 30 September 2013.

A brief summary of our observations and comments are as follows:

- (a) The inspection comprised of a walkover review of the exterior of the building only.
- (b) Since the last inspection completed by Structex Metro Limited on 25 June 2012, the condition of the building has degraded further on all sides. This generally includes additional cracks in the exterior plaster finishes at locations where damage had not previously been observed, plus significant cracks and degradation of the north wall.
- (c) The north wall in particular, that is located on the north boundary, has suffered significant additional damage. This includes:
 - (i) Significant horizontal wide crack near base of the parapet.
 - (ii) Diagonal shear cracks in the wall at the lower storey.
 - (iii) Regular spaced horizontal cracks at approximately 1m centres, plus widespread random cracks generally throughout the elevation as a whole.
 - (iv) New vertical crack at the north-east corner (north face), which may be at an interface between the concrete corner column and brick infill.
 - (v) New horizontal crack at north-east corner (east face) near base of parapet.
- (d) To the remainder of the north wall that is set back from the boundary, a large number of additional cracks noted throughout the elevation.
- (e) To the east, south and west elevations, additional cracks noted and/or have widened at the base of the parapet to the roof and generally throughout the elevations in the large wall/pier elements.



3. Assessment of Additional Damage & Response to CERA & Aurecon Letters

The key items of concern raised by CERA and Aurecon and subsequent comments and responses from Structex Metro Limited are as follows:

(a) CERA Concerns

(i) The Detailed Engineering Evaluation Report (DEE) completed by Structex Metro Limited dated 8 November 2011 'is preliminary only and out-dated as it was prepared before a series of major aftershocks, also the report does not provide the Excel summary'.

Structex Metro Limited agrees that the report is out of date. Our most recent inspection of the exterior of the building confirms that further degradation of the building as a whole has occurred.

The DEE report comprised of a quantitative analysis of the North building, and assessed the building in both an undamaged and damaged state.

In the undamaged state, the North building was assessed at 25%-55% x NBS (New Building Standard).

In the damaged state the North building was assessed at 15%-40% x NBS.

The building has been assessed by Structex Metro Ltd as being earthquake prone with strength \leq 33% x NBS.

With the additional damage observed in Structex' recent inspection, this is unlikely to change the previous assessment as it was assumed then that the main damaged brick infill walls would not contribute to the over lateral resistance in the damaged state.

However, we reiterate that the building was assessed as being earthquake prone and the lateral resisting strength in parts of the North building could be as low as $15\% \times NBS$.

The summary spreadsheet will be completed and forwarded in due course.



(ii) `The building appears to have received substantial earthquake related damage, has Critical Structural Weaknesses, and its estimated NBS is less than 33%, therefore the building is earthquake prone and potentially dangerous.'

Structex Metro Limited agrees.

(iii) *CERA will leave in place the existing Notice under Section 45 of the Canterbury Earthquake Recovery Act limiting access to and around the building to that of emergency purposes, damage assessment or making safe.'*

Structex Metro Limited agrees that these restrictions remain in place.

It is noted that the North building has suffered significantly more damage than the South building which is mainly due to differences in the construction. The North building has a larger number of interior heavy unreinforced masonry block walls, plus includes the main stair and lift wells and basement.

It is also noted that the alley way space between the west side exterior wall of Harley Chambers and the adjacent building to Worcester Boulevard acts as an emergency fire egress route to the adjacent building.

(iv) 'You, as the building's owner are required to take all practical steps to ensure the safety of the building and the people around it. These steps should follow any recommendations of your engineer and may include restricting access into and around the building by fencing, placing warning signs or other means.'

Structex Metro Limited provides comments as follows:

- The Harley Chambers building comprises of a North and South building that are separated by a nominally small joint.
- The North building has suffered significant damage and has been assessed by Structex Metro Ltd as earthquake prone and potentially dangerous, with lateral resisting strength ≤33% x NBS.



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- The South building has suffered less damage and is in a better overall condition. A detailed quantitative analysis of the South building has not been undertaken. Given that it has a lesser number of interior heavy unreinforced masonry block walls then the lateral resisting strength will be higher than the North building. It may have an assessed strength ≥34% x NBS (to be confirmed).
- The scope and cost of repairs have been assessed in detail. The estimated costs to repair and/or strengthen the building to ≥34% x NBS are very large. We understand that there is some disagreement with the Insurer regarding the extent of the repairs and costs.

It is Structex Metro Limited's opinion that the repair of the North building is uneconomic. In addition, the north-east corner of the building has suffered higher differential settlements than the rest of the building. The feasibility of re-levelling this corner of the building is questionable and at the very least would be complex and costly.

- The north section of the wall directly adjacent to the boundary has degraded significantly. The parapet needs to be removed and the unreinforced brick infill removed or significantly secured to allow the safe construction of the new adjacent building to be undertaken. This needs to be completed immediately.
- The South building is not likely to pose a danger to the public or people around it, at this stage. However, its condition needs to be monitored regularly.
- To date, the condition of the North building, while very poor, has not required Structex Metro Limited to advise on whether it should be deconstructed or not. The height to width aspect ratio is low, and there is residual capacity within the concrete frames and unreinforced masonry block structure, so the risk of instability has been assessed as low.



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However, with the construction of the new building on the adjacent site at 141 Cambridge Terrace about to commence, and the significant degradation of the north wall to the North building of Harley Chambers, then immediate action is required.

While there is some disagreement between the owner and their Insurer regarding the extent of the earthquake repairs and associated costs, it is the opinion of Structex Metro Limited that the earthquake repairs to reinstate the North building back to its preearthquake condition will not be economically viable.

- Taking into account the above noted issues, Structex Metro Limited recommends that the North building of Harley Chambers be deconstructed as soon as possible. This will ensure the following:
 - The safety concerns raised by Aurecon regarding the construction of the new building at 141 Cambridge Terrace will be addressed.
 - Elimination of hazards associated with the main parapets that front onto Cambridge Terrace footpath (currently part fenced) and road, where cracks at the base of the parapets and at the north-east corner junction with the concrete frame have increased and degradation is ongoing.
 - Provides a safe fire egress from the adjacent building at Worcester Boulevard so that they could exit across the site to Cambridge Terrace instead of along the alley way access that is directly adjacent to the South building of Harley Chambers that has unreinforced brick parapets.
 - Provides a rational approach to addressing the repairs to the North building, in the opinion of Structex Metro Limited.



(b) Aurecon Concerns

(i) 'Work along the Harley Chambers boundary is unsafe.'

Refer to comments made in 3(a)(iv).

(ii) 'Unable to inspect structure to the interior section of the building adjacent to 141 Cambridge Terrace boundary to confirm stability of the wall and integrity of the floor and roof diaphragm connections.'

Refer to comments made in 3(a)(iii). Restricted access is recommended.

Given the damage and current condition of the north wall, the parapet is at risk of collapse, plus there is a risk of partial collapse of the brick infill to this wall, especially in a large earthquake.

Therefore the risks to personal safety of investigating the integrity of the floor and diaphragm connections is high.

Refer comments and recommendations made in 3(a)(iv) to address the issues of safety to all parties, with recommendation for full deconstruction of the North building of Harley Chambers as soon as possible.

(iii) 'We have significant concerns for life safety to personnel working close to Harley Chambers and the possibility of further damage to the building due to vibration affects from driving sheet piles adjacent to weakened and already damage building.'

Structex Metro Limited shares these concerns. Refer comments in 3(a)(iv).

(iv) 'We are concerned the construction work will be stopped....'

Reiterating our previous recommendation, it is recommended that the North building to Harley Chambers be deconstructed as soon as possible. This may require approval and/or assistance from CERA.



4. Summary & Recommendations

A brief summary of our recent inspection and assessment is as follows; together with recommendations by Structex Metro Limited.

- (a) Concerns have been raised by both CERA and Aurecon regarding safety to people around the building, including personnel working on the adjacent site to the north boundary as part of the construction of a new building at 141 Cambridge Terrace.
- (b) The Harley Chambers building has suffered additional damage since it was last inspected by Structex Metro ltd on 25 June 2012. Significant additional damage has occurred to the north wall of the North building.
- (c) The building has been assessed as being earthquake prone and potentially dangerous, with lateral strength \leq 33% x NBS. Parts of the North building could be as low as 15% x NBS.
- (d) The condition and stability of the north wall to the North building of Harley Chambers poses a life safety danger to people around the building.
- (e) It is the opinion of Structex Metro Limited that the North building of Harley Chambers is uneconomic to repair.
- (f) Structex Metro Limited recommends that the North building to Harley Chambers be deconstructed as soon as possible. This addresses the issues raised concerning life safety danger to people around the building, including fire egress from the adjacent building in Worcester Boulevard.
- (g) To avoid potential stoppage of construction work on the adjacent site at 141 Cambridge Terrace, assistance will be required from CERA to action the deconstruction of the North building.



This letter/report needs to be forwarded to CERA as soon as possible, and your Insurers will also need to be notified.

If you, CERA, or other parties require clarification of any of the above, or need to meet to discuss, then please contact the undersigned.

Yours sincerely Structex Metro Ltd

5 a Gulmore

Brett Gilmore CP Eng (# 139988) B.Eng (Hons)(Civil) Senior Structural Engineer & Director MIPENZ; PE (USA) Int PE

Attachments:

- 1. Copy of CERA letter dated 27 September 2013
- 2. Copy of Aurecon letter dated 8 October 2013
- 3. Copy of Detailed Engineering Evaluation Report dated 8 November 2011.

