structex

Project 5906 – 14th February 2012

# Riccarton House

# Detailed Engineering Evaluation Report

ACENZ

strategy • engineering • design

## Contents

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14th February 2012

John Radburn
Insight Unlimited NZ
Project & Construction Managers
Email: john@insight-unlimited.co.nz

Dear John,

**Re: Riccarton House**
**Detailed Engineering Evaluation**

## Introduction

Structex has been engaged to complete a detailed engineering evaluation for Riccarton House at 16 Kahu Road, Riccarton, Christchurch. This report summarises the findings of our detailed engineering evaluation, which was undertaken in accordance with guidelines prepared by the Post-Canterbury earthquake Engineering Advisory Group (EAG). At the time of writing this report, these guidelines were in draft format (revision 5, released through CSG, 19th July 2011) and under review with the Department of Building and Housing (DBH). Qualitative and quantitative assessments have been carried out. More specifically, this report:

(a) Highlights Building Act requirements and the Christchurch City Council policy for earthquake-prone buildings

(b) Describes the existing building, its construction, and structural system

(c) Outlines the level of investigation undertaken and where information was obtained

(d) Summarises earthquake damage caused by the recent Canterbury earthquakes

(e) Reviews the building's performance in the recent Canterbury earthquakes

(f) Identifies critical structural weaknesses

(g) Assesses the building's seismic strength relative to New Building Standard (NBS), commonly referred to as "current code"

(h) Outlines repairs to restore the building to its pre-earthquake condition

(i) Proposes earthquake strengthening work to bring the building as close as practically possible to 67% of current code

## Limitations of Report

Findings presented as part of this report are for the sole use of our client, as addressed above. 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.

## Executive Summary and Recommendations

Riccarton House has been damaged as a result of the recent Canterbury earthquakes. This report summarises our detailed engineering evaluation of the building following these earthquakes. Qualitative and quantitative assessments have been carried out.

Damage to the building included isolated cracking to the perimeter foundation wall, minor cracking between weatherboards, minor to severe damage to internal lath and plaster linings, severe damage to brick chimneys and differential settlement to the morning room bay window.

From our visual inspections and review of architectural floor plans we did not identify any critical structural weaknesses. This was on the basis that timber framed structures are typically well tied together and there was no evidence of walls disconnecting from horizontal diaphragms.

The building as it currently stands in its damaged state has a seismic strength of less than 33% of new building standard (NBS), and is therefore considered to be earthquake-prone. Strengthening to 67% of NBS will be required as per the Christchurch City Council Earthquake-prone Building Policy.

Options to repair the building include:

- Local repairs to lath and plaster linings with minor damage
- Replacement of moderately-severely damaged lath and plaster linings
- Sealing cracks to the foundation wall with a pressure injected epoxy
- Demolition and reconstruction of the morning room bay window
- Demolition of brick chimneys and replacement with strengthened versions.

An option to strengthen the building as close as practically possible to 67% of NBS has been proposed by relining selected walls with 12mm bracing plywood and providing adequate panel hold down fixings. Due to the lack of sufficient wall lines and tall stud height, the work is insufficient to achieve 67% of NBS. However, given the building is lightweight and has performed reasonably well in the recent earthquakes, we believe the risk to life is low enough to accept strengthening to a lower level.

The building is listed in both the Christchurch City Plan and the Historic Places Trust register as a category 1 heritage building. Therefore repair and strengthening works will be subject to resource consent requirements.

The level of strengthening should be discussed with the building owner, insurer and Christchurch City Council. Once the level of strengthening has been agreed and any other specified structural alteration work has been defined, we can finalise the design and document the work for Building Consent.

# 1 Statutory Regulations concerning Existing and Earthquake-prone Buildings

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

## 1.1 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, earthquake-prone, 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.

## 1.2 Christchurch City Council (CCC) 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 (Post-disaster 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 required level for strengthening of earthquake-prone buildings. However, the council may allow strengthening to levels between 33% and 67%, on a case by case basis, 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.

## 1.3 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.

## 2 Building Description

### 2.1 General description

| | |
|---|---|
| *Building name:* | Riccarton House |
| *Address:* | 16 Kahu Road, Riccarton, Christchurch |
| *Building use:* | Restaurant, private venue, and Heritage site |
| *Heritage category:* | 1 |
| *Number of storeys:* | Two |
| *Roof construction* | Timber shingles, on timber sarking, on timber trusses. |
| *Wall construction:* | Timber framed, with timber weatherboard cladding to exterior and lath and plaster linings to interior. Exterior walls of the 1856 buildings have clay brick insulation. |
| *Floor construction:* | Timber tongue and groove flooring on timber joists. |
| *Subfloor construction:* | Timber bearers on shallow concrete piles, and unreinforced concrete foundation wall. |
| *Year built:* | 1856, 1874 and 1900 |
| *Approx. floor area:* | 915 $m^2$ |
| *Building Importance:* | 2 (NZS1170.0) |

Riccarton house is listed in both the Christchurch City Plan and the Historic Places Trust register as a category 1 heritage building. This means that repair and/or strengthening work will be subject to resource consent requirements.

### 2.2 Structural System

The gravity structural system consists of floor/ceiling joists spanning onto external and internal wall lines, which in turn are supported on the floor below. The ground floor consists of floor joists over timber bearers, which are supported on shallow concrete piles or the unreinforced concrete perimeter foundation wall. We believe external wall studs extend full height with first floor joists side fixed to each stud, as oppose to adopting a top plate detail.

The lateral load resisting system is provided by lath and plaster lined timber framed walls acting as in-plane diaphragms. Tongue and groove floors and lath and plaster ceilings act as horizontal diaphragms between in-plane wall elements. Vertical timber studs span between floor levels providing out-of-plane resistance.

## 3 Scope of Investigation

Our detailed engineering evaluation has been undertaken in accordance with Engineering Advisory Group (EAG) guidelines "Guidance on Detailed Engineering Evaluation of Earthquake Affected Non-residential Buildings in Canterbury". At the time of writing this report, these guidelines were in draft format (revision 5, released through CSG, 19th July 2011) and under review with the Department of Building and Housing (DBH). Qualitative and quantitative assessments have been carried out.

Our building evaluation and assessment has been based on the following information:

(a) Several visual inspections of the building carried out in October and November 2010, and March, April and October 2011, which collectively included:
   - The exterior from ground level
   - The interior, excluding one storey lean-tos at ground floor
   - The roof space
   - The subfloor space as viewed from a floor hatch at the southern end of the building.

(b) Architectural floor plans obtained from Tony Ussher Heritage and Conservation Architect.

(c) Geotechnical investigation and report (See Appendix D) provided by Land Development & Exploration Ltd, which included:
   - A desk study
   - 1 no. Hand Auger boreholes
   - 2 no. Dynamic Penetrometer Tests (SPT)

We highlight that the type of construction was obtained from visual inspections of exposed timber framing in the morning room of the 1856 building, from within the roof space and where chimney 2 (eastern most 2-flue chimney) had been deconstructed to first floor level.

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

- Compliance items covered by the building Warrant of Fitness (A list of such items has been included in Appendix A)
- 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 Building Performance in recent Canterbury Earthquakes

## 4.1 Earthquake Damage

Damage observed is briefly described below. Photos and marked-up sketches are included in Appendix B and Appendix C respectively to indicate the location and nature of the observed damage. These are not meticulous or comprehensive records of all damage but have been included to provide an indication of the damage.

- Minor isolated cracking to perimeter foundation wall all round.
- Cracking/separation between timber weatherboards, particularly at wing junctions.
- The elevated water tank at the southern end of the building has been displaced on its supporting timber framed tower.
- Rear porch framing has displaced relative to its concrete landing.
- 1-3mm ground crack extending under morning room bay window. This bay window has also pulled away from the main building, which appears to be the result of differential settlement.
- 30-50mm ground cracking to lawn between Avon Stream and footpath. One 2-3mm ground crack passed under the morning room bay window.
- Severe damage to all chimneys, except chimney 6, following the 4th September 2011 earthquake. These were subsequently deconstructed to first floor ceiling level. Chimney 6 suffered severe damage following the 22nd February earthquake 2011, and was then also deconstructed to first floor ceiling level. We understand the first floor chimney breast of chimney 2 collapsed during the 22nd February earthquake.
- Minor-moderate cracking to remaining chimney breasts and fireplace bricks, particularly chimneys 2, 3, 4 and 6.
- Damage to internal lath and plaster wall linings through-out. Damage ranged from minor cracking to severe cracking and delamination. Damage was more significant to the ground floor than the first floor. We note that whilst several linings appeared intact, in some cases, the plaster at the bottom corners had noticeably softened.
- Damage to lath and plaster ceiling linings through-out. Damage ranged from minor cracking to local spalling and delamination.
- Moderate damage to ceiling scotia in drawing room.

## 4.2 Review of Building Performance

Generally damage sustained by Riccarton House was typical for its age and construction.

Isolated cracking to foundation walls, separation to weatherboards, cracking to lath and plaster linings and damage to chimneys are all typical damage observed to early 1900's timber framed structures.

Damage is typically greater to ground floor walls than first floor walls due to the additional seismic weight of the floor above, and this was clearly evident at Riccarton House. Greater damage was also observed to the 1856 building which had additional weight from brick insulation in exterior walls.

The ground floor study in the 1856 building suffered severe damage with wall and ceiling linings delaminating completely from timber framing. This could be attributed to the lack of bracing in the adjacent morning room. The morning room had much of its lath and plaster wall linings removed to expose brick insulation as an exhibit of historic construction. This essentially removes much of the bracing to this room, overloading the adjacent study.

Ground cracking is the result of lateral spreading towards the nearby Avon Stream, which is to be expected near such waterways.

## 4.3 Critical Structural Weaknesses and Building Resilience

From a review of existing floor plans and visual inspections of the building, we did not identify any critical structural weaknesses. This was on the basis that timber framed structures are typically well tied together and we did not observe any evidence of walls disconnecting from horizontal diaphragms.

## 4.4 Areas Requiring Further Investigation

We understand brick insulation was still used for buildings constructed in 1874, however no brick insulation was observed to the first floor walls adjacent chimney 2. Thus herein it has been assumed that there is no brick insulation to the 1874 building. We recommend this assumption is confirmed with further invasive investigation.

In addition we recommend:

- Fixing of wall bottom plates to foundations walls.
- Vertical alignment surveys of the morning room and study walls.

## 5 Seismic Assessment

A seismic assessment of the building has been carried out in 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. The building has been assessed as an Importance Level 2 (normal) building, and assuming soil class D and structural ductility of 3. The building was assessed as three buildings separated according to their year of construction.

The capacity of lath and plaster walls was calculated in accordance with New Zealand Society for Earthquake Engineering (NZSEE) "Assessment and Improvement of the Structural Performance of Buildings in Earthquakes" guidelines (June 2006). Lath and plaster capacities were then reduced to 0%, 25%, 50% or 75% depending on the extent of damage observed to the wall from our visual inspections.

We note that while the Buildings Act "deems a building earthquake prone if its ultimate strength capacity is exceeded in a moderate earthquake, and the building would be likely to collapse", the NZSEE guidelines and CCC policy refer to a percentage of New Building Standard (%NBS). Currently 33% of NBS has been adopted as the threshold below which a building is considered earthquake-prone. 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.

| **ITEM** | **LEVEL** | **%NBS** | |
|---|---|---|---|
| | | **N-S direction** | **E-W direction** |
| 1856 Building in-plane bracing | First floor | 65% | 41% |
| | Ground floor | **<10%** | **<10%** |
| 1874 Building in-plane bracing | First floor | 100% | 80% |
| | Ground floor | **18%** | 41% |
| 1900 Building in-plane bracing | First floor | 91% | 100% |
| | Ground floor | **28%** | **18%** |

The results of this assessment indicate that all three buildings are earthquake-prone in terms of in-plane bracing at ground floor. Therefore strengthening to 67% of code is required by the CCC Earthquake-prone Building Policy. We highlight that the assessment of the 1874 building assumed no brick insulation, which requires further confirmation.

# 6 Earthquake Repairs and Strengthening Work

This section describes repair works to restore the building to its pre-earthquake condition, and additional works to strengthen the building as close as practically possible to 67% of current code. In some cases, further investigation of existing construction will be required. Where appropriate, this has been noted in Section 4.4.

Repair and strengthening work proposed in this report have sought to preserve heritage features as much as possible. Such features include decorative scotia, plaster ceiling roses, decorative timber wall panelling, tongue and groove floor boards, timber skirtings and lath and plaster walls. Measures to retain heritage fabric include avoiding relining areas with decorative timber panelling, replacing already damaged lath and plaster walls first and retaining tongue and groove flooring. We have allowed the morning room to remain as an exhibit of historic construction by applying any plywood strengthening to the external wall face.

## 6.1 Repairs

This section describes options of repair to restore the building to its pre-earthquake condition. These repairs are subject to change as the works proceed and as further information regarding existing construction and the extent of damage is revealed. On-site correspondence with the contractor carrying out the works may be required.

The costs associated with the repairs will require assessment by a quantity surveyor and/or qualified contractor who will need to visit the site to view the extent of damage and work required.

*Repair to morning room bay window:*

- Deconstruct morning room bay window. Prior to demolition, take photographic records of original construction as directed by the council heritage team.
- Excavate for new strip foundation.
- Lay compacted hardfill, sand binding, DPM and cast new reinforced strip foundations. Tie new foundations into existing foundations.
- Reconstruct bay window to match original.

*Repair to perimeter foundation wall:*

- Seal cracks to perimeter concrete foundation wall using a pressure injected epoxy. Install as per manufacturers specification.

*Repair to ground crack under morning room:*

- Excavate to base of ground crack. Relay compacted hardfill. We recommend utilising geotextile reinforcement.

*Repair to damaged internal wall and ceiling linings:*

- For repairing lath and plaster, refer GIB Bulletin "Repairing lath and plaster walls and ceilings" (January 2011):
- For minor isolated cracks to lath and plaster linings (smaller than 300mm in any direction), grind-out V-shaped groove along crack. Re-plaster over groove, utilising fibreglass mesh reinforcement across the crack.
- For larger cracks/fractures to plaster linings, remove and replace with GIB in accordance with GIB literature. As existing lath and plaster is 25mm thick, we suggest lining with 12mm plywood and 13mm standard GIB. Alternatively, engage specialist tradesperson to break-out cracked plaster to expose timber laths locally, re-fix laths to timber framing, and re-plaster over.
- Lath and plaster linings which have crushed plaster at bottom corners or have delaminated will required replacement with 12mm plywood and 13mm standard GIB.
- Sand, prime and repaint over to match existing.

*Repair to chimneys:*

- Due to damage to internal brick flues and fireplaces, we recommend chimneys 2, 3, 4, 6 and 7 be deconstructed to the top of the ground floor fireplace. Prior to demolition, take photographic records of original construction as directed by the council heritage team. Retain ground floor fireplaces for re-use.
- We recommend replacement chimneys and breasts be strengthened versions such as a brick veneer on lightweight steel braced framing. Refer next section regarding strengthening.

*Other non-structural repairs:*

- Refix water tank securely to supporting timber framed tower.
- Realign and re-fix any dislodged timber weatherboards. Sand, prime and repaint over to match existing.
- 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.

### 6.2 Strengthening to 67% NBS

In addition to the repairs outlined in the previous section, the following work is required to strengthen the building as close as practically possible to 67% of current code. For highlighted walls in sketches included in Appendix E:

- Remove lath and plaster linings (or external weatherboards as appropriate)
- Re-line wall with 12mm H3.1 bracing plywood. Fix plywood to studs, dwangs and plates with 3.15dia x 45mm flat head nails at 100mm centres to sheet perimeter, and at 300mm centres elsewhere. Provide 16kN holddown fixings to panel corners. Other fixing details (such as fixing edge distances) to comply with Ecoply bracing literature.
- Overlay with 13mm standard GIB as per GIB literature to provide flush plaster surface with existing lath and plaster.
- Allow to remove and reinstate 1100-1200mm high paneling where required, such as in the ground floor passage, office, kitchen and staff living room.
- We understand that the catering kitchen is to be refurbished and kitchen joinery will be removed to allow access to wall lines.
- Reconstruct chimney breasts in steel framing battened out with timber and lined with GIB. Reconstruct chimneys above as brick veneers on steel framing. Refer drawings in Appendix E.
- Note that the above works requires other damaged lath and plaster walls and ceilings to be repaired as described in the previous section.

Due to the lack of sufficient wall lines given the size of the building, and the tall stud height, extensive relining of ground floors walls is insufficient to achieve 67% of NBS. The table below summarises the percent of NBS achieved with the proposed strengthening.

| **ITEM** | **LEVEL** | **%NBS** | |
|---|---|---|---|
| | | **N-S direction** | **E-W direction** |
| 1856 Building in-plane bracing | First floor | 87% | 69% |
| | Ground floor | **56%** | **52%** |
| 1874 Building in-plane bracing | First floor | 100% | 100% |
| | Ground floor | 71% | 68% |
| 1900 Building in-plane bracing | First floor | 100% | 100% |
| | Ground floor | **66%** | **60%** |

Whilst the first floor is able to achieve 67% of NBS with repair and minor strengthening, the ground floor typically achieves above 60% of NBS and 52% of NBS in the worst case.

We understand that the council may allow strengthening to below 67% of NBS depending on factors such as cost, risk posed, building use and the damage observed. Given the building is lightweight timber framing, has performed rather well during the recent earthquakes, and work proposed will only improve the seismic performance of the building, we believe the risk posed is low enough to consider strengthening to less than 67% of NBS. We recommend initiating discussions with council to agree upon a level of strengthening.

Failing this, other forms of strengthening will be required. Such strengthening could take the form of:

- New internal wall lines to provide additional bracing
- Steel braced frames with new foundation beams. As such frames would be used to attract much of the seismic load, additional strengthening to floor/ceiling diaphragms will likely be required. Diaphragm strengthening could take the form of plywood over/underlays or diagonal steel plates.

Such work is highly invasive, impacts upon the floor layout and floor space, hence our recommendation to pursue strengthening to lower levels with the council.

The geotechnical report prepared by Land Development and Exploration Limited noted negligible settlement under an ultimate limit state event. The report also notes a net extension of 10mm across the building footprint is possible from lateral spreading. We do not consider extension of this magnitude will pose a risk to life safety and therefore have not allowed for foundation improvement to mitigate lateral spreading.

### 6.3 Strengthening to 33% NBS

To allow comparison with the option to strengthen to 67% of NBS, Structex was requested to outline strengthening work required to bring the building to 33% of NBS.

For the most part, repairing and restoring the original strength of lath and plaster linings with inherently strengthen the building to 33% of NBS. The 1856 building is the exception and will require 12mm plywood bracing (similar to Section 6.2) to morning room and study walls as shown in Appendix F. This excludes strengthening required to replacement chimneys.

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

Yours sincerely,
**Studio2 Ltd**

Euving Au
B.E.(hons), M.E., GIPENZ
Structural Engineer
Studio2 Limited

Reviewed by,
**Studio2 Ltd**

Will Lomax
B.Eng(hons), IntPE, CPEng#226903
Director
Studio2 Limited

## Appendix A: Christchurch City Council Compliance Schedule

| | |
|---|---|
| 1. Automatic systems for fire suppression (for example, sprinkler systems) | ☐ |
| 2. Automatic or manual emergency warning systems for fire or other dangers (other than a warning system for fire that is entirely within a household unit and serves only that unit). | ☐ |
| 3. Electromagnetic or automatic doors or windows (for example, ones that close on fire alarm activation) | |
| 3.1 Automatic Doors | ☐ |
| 3.2 Access controlled doors | ☐ |
| 3.3 Interfaced fire or smoke doors or windows | ☐ |
| 4. Emergency lighting systems | ☐ |
| 5. Escape route pressurisation systems | ☐ |
| 6. Riser mains for fire service use | ☐ |
| 7. Automatic back-flow preventers connected to a potable water supply | ☐ |
| 8. Lifts, escalators, travelators, or other systems for moving people or goods within buildings | |
| 8.1 Passenger-carrying lifts | ☐ |
| 8.2 Service lifts including dumb waiters | ☐ |
| 8.3 Escalators and moving walks | ☐ |
| 9. Mechanical ventilation or air conditioning systems | ☐ |
| 9a. Cooling tower as part of an air conditioning system | ☐ |
| 9b. Cooling tower as part of a processing plant [not a specified system] | ☐ |
| 10. Building maintenance units for providing access to the exterior and interior walls of buildings | ☐ |
| 11. Laboratory fume cupboards | ☐ |
| 12. Audio loops or other assistive listening systems | ☐ |
| 13. Smoke control systems | |
| 13.1 Mechanical smoke control | ☐ |
| 13.2Natural smoke control | ☐ |
| 13.3Smoke curtains | ☐ |
| 14. Emergency power systems for, or signs relating to, a system or feature specified in any of the clauses 1 to 13 | ☐ |
| 14.1Emergency power systems | ☐ |
| 14.2Signs | ☐ |
| 15. Other fire safety systems or features | ☐ |
| 15.1Systems for communicating spoken information intended to facilitate evacuation | ☐ |
| 15.2Final exit (as defined by A2 of the Building Code; and | ☐ |
| 15.3Fire separations | ☐ |
| 15.4Signs for communicating information intended to facilitate evacuation | ☐ |
| 15.5Smoke separations | ☐ |
| 16. Cable Car (including to individual dwellings) | ☐ |

## Appendix B: Photos of damage

Ground cracking between path and stream

Morning room bay window pulled away from main building

Minor isolated cracking to foundation wall

Minor isolated cracking to foundation wall

Rear porch framing displaced from concrete landing

Separation between timber weatherboards

Separation between timber weatherboards

Displaced water tanks

Morning room bay window from inside

Ground crack extending under morning room bay window


Lath and plaster wall and ceiling delamination in study


Diagonal cracking to lath and plaster wall in drawing room


Cracking to drawing room scotia


Lath and plaster ceiling delamination in study


Lath and plaster ceiling delamination in dining room


Diagonal cracking to lath and plaster wall in dining room


Collapse of chimney 2 breast at first floor


Damage to chimney 6 breast at first floor


Cracking to lath and plaster walls at rear stair well


Cracking to lath and plaster walls at rear stair well

Localised damage to roof framing from chimney

Damage to base of chimney 6

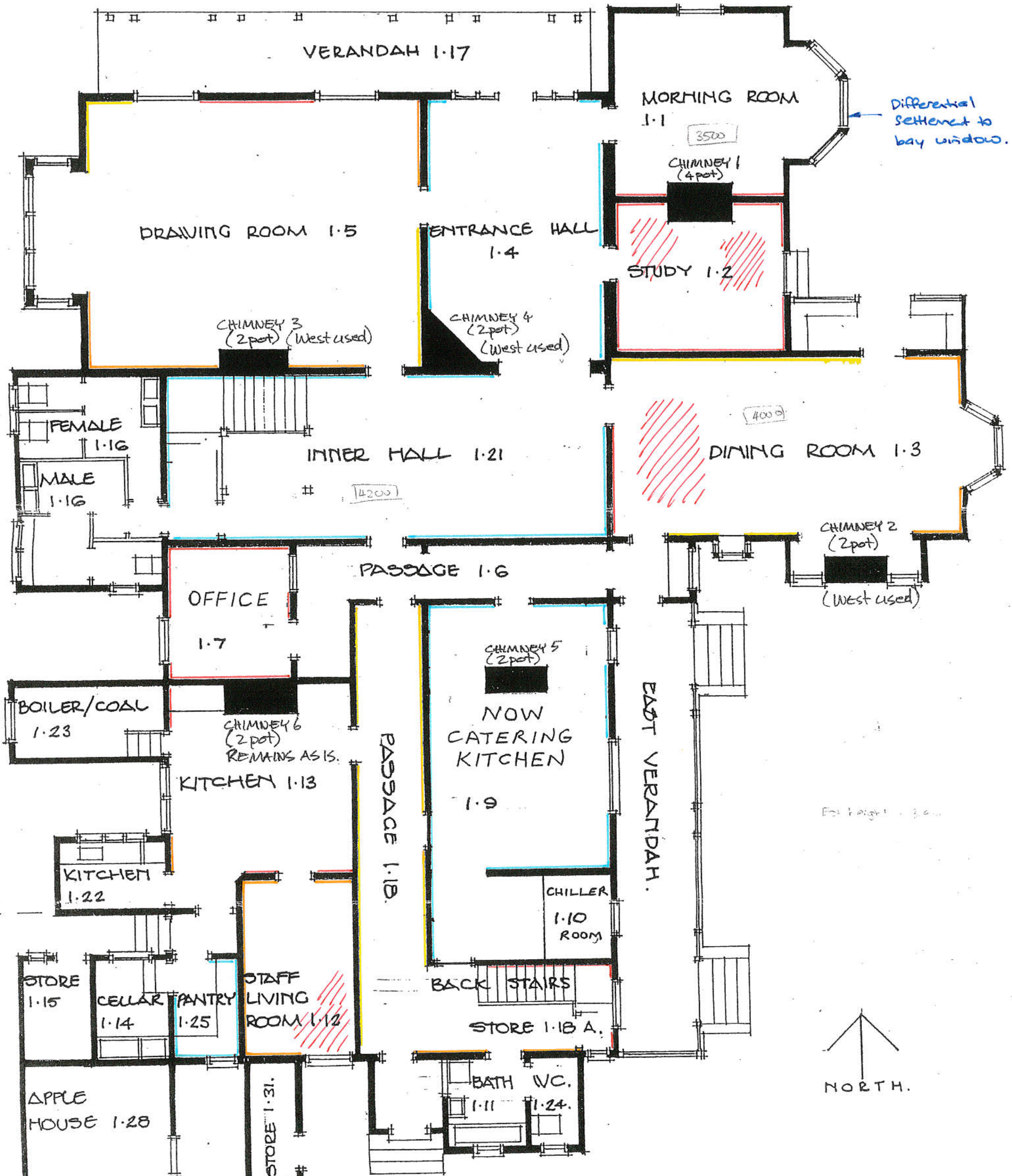
Subfloor space

## Appendix C: Marked-up sketches of damage

Damaged Locations

Structex mark-ups 10/10/11 - EA

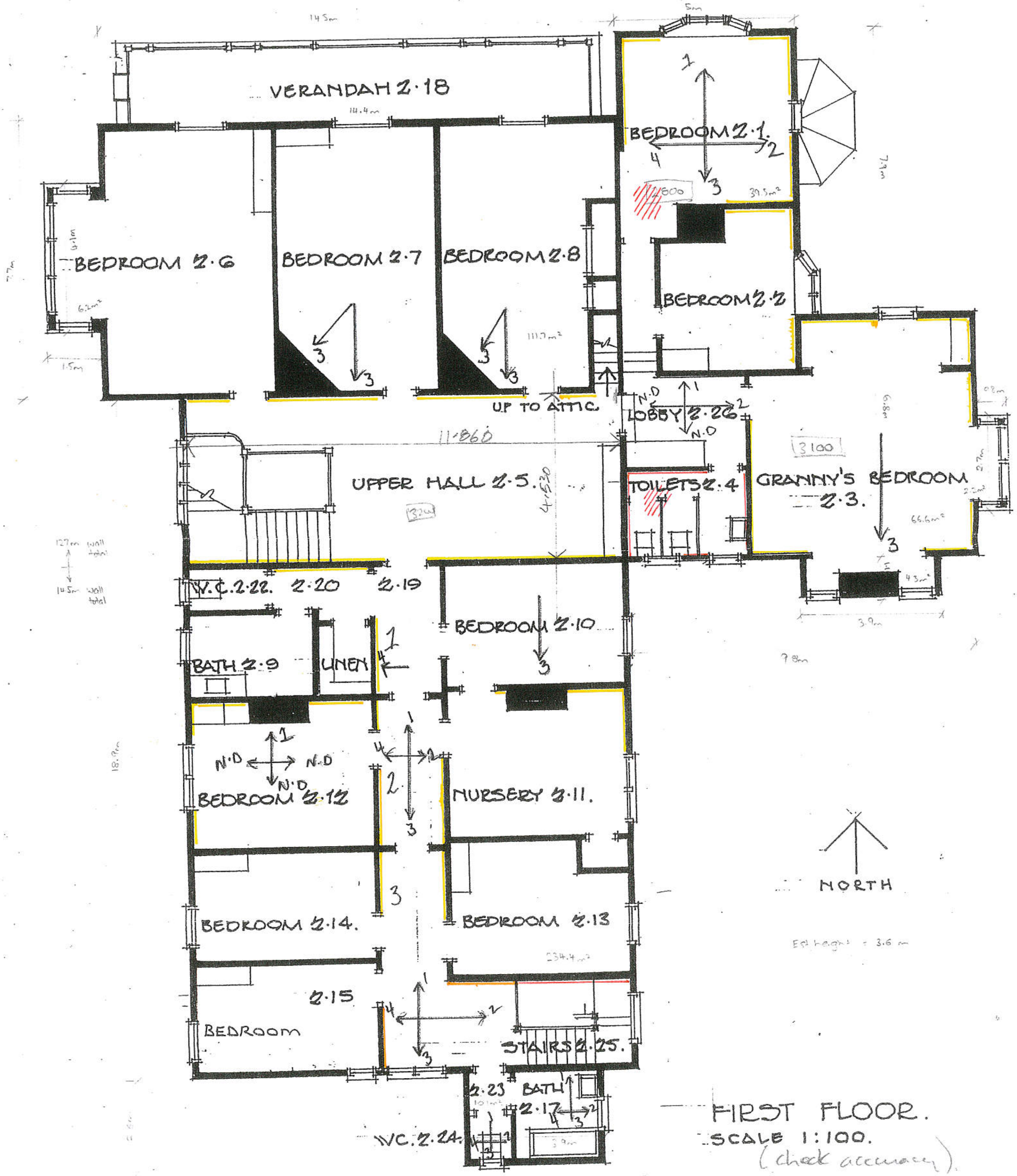
- Severe damage to linings
- Moderate damage to linings
- Minor damage to linings
- Timber panelling or other linings concealing substrate.
- Spalled ceiling linings




GROUND FLOOR SCALE 1:100. (check accuracy)

OLD LAUNDRY CHIMNEY 7. (2 pot).

* N·D = NO DAMAGE




FIRST FLOOR.
SCALE 1:100.
(check accuracy)

RICCARTON BUSH TRUST
P.O. BOX 8276 CHRISTCHURCH
PHONE 341 1018 FAX 341 6839

## Appendix D: Geotechnical Report

# Christchurch City Council

# Riccarton House

# Detailed Geotechnical Investigation Report

Project Reference: 10048
13 September 2011

# 1 Introduction

Land Development & Exploration Ltd was engaged by Insight Unlimited on behalf of Christchurch City Council to undertake a detailed geotechnical investigation of the ground beneath buildings and land at Riccarton House, Riccarton. The buildings and land were damaged by earthquake shaking, particularly from the 22 February 2011 earthquake event.

The purpose of the investigation was to assess the stratigraphy and strength of the materials beneath the northeastern corner of the building (viz bay window area) to assist with the foundation design to remediate that part of the building.

This work follows on from a preliminary assessment of the property in July 2011.

# 2 Situation

Riccarton House comprises a large 2 storey house with weatherboard claddding located some 20m back from a tributary of the Avon River (Figure 1).

Figure 1: Northern side of Riccarton House. Damaged bay window in left of view.

The building foundations appear to comprise strip footings beneath load bearing walls, and suspended timber floors in the intervening areas.

The house has suffered little in the way of damage associated with land deformation with only a small crack extending into a bay window at the northeastern corner being the only apparent evidence of this. The riverbank slope leading up to the footpath along the crest of the riverbank has yielded and it is likely that the hairline crack is a secondary feature associated with the minor relaxation of land behind the riverbank slope. All other damage appears to be from earthquake shaking, with no obvious settlement associated with liquefaction being apparent.

There appears to be a low risk of further damage of significance associated with lateral spreading, although opening up of the hairline crack in the northweastern bay window area may be possible with large earthquakes. We do not expect that this would result in damage sufficient to warrant ground improvement measures to reduce the potential.

The footpath along the crest of the riverbank has also been relatively unaffected by movement. Future movement may potentially result in its disruption, however the cost to inhibit this is expected to greatly exceed the benefit in doing so.

The remedial work is expected to comprise of the replacement of the bay window footing.

# 3 Detailed Investigations

The detailed investigation of the site included the following work;

- One 50mm handaugered borehole put down to 2.6m depth.
- Two dynamic penetrometer tests to depths of up to 2.5m.
- Observations and measurements of the soil moisture content and levels of groundwater encountered down through the borehole.

The locations of the subsurface investigations are shown in Figure 2. Logs of the borehole and penetrometer tests are appended.

The field work was completed in winter.

All work was completed by qualified geological-geotechnical specialists.


Figure 2: Investigation locations

# 4 Engineering Geology

## 4.1 General

The engineering geology of the site is summarised below. It is based on an integration of published and unpublished data, the geomorphology of the site, and subsurface investigations carried out at discrete locations. The nature of the ground between the investigation points is inferred and may vary from that described. For details of the materials encountered and measurements of their respective strengths please review the appended investigation logs.

## 4.2 Subsurface Conditions

Handauger HA1 and penetrometer test P1 show that the bay window is generally underlain by beds of stiff to very stiff clayey silt, silty clay and sand overlying very dense sand (probably gravelly) from 2.4m depth (Figure 3).

The surface soils down to 0.6m comprise very stiff clayey silt and overlie a 0.7m thick layer of loose sand.

Penetration resistance in the very dense sand from 2.4m depth is more than 14 blows per 50mm.

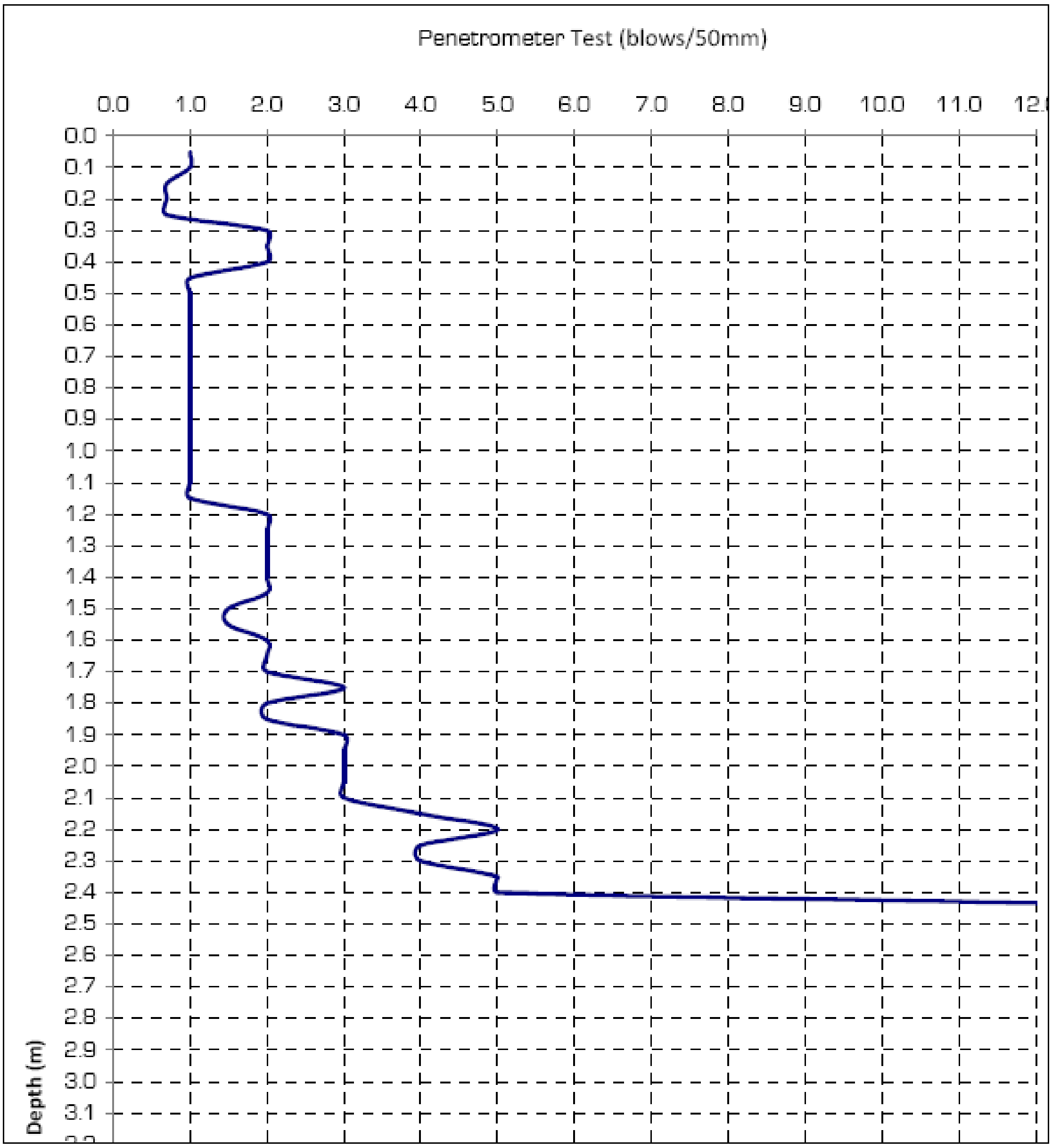



Figure 3: Penetrometer P1 strength profile beneath bay window.

## 4.3 Soil Moisture Profile and Groundwater Conditions

Groundwater was encountered at 1.8m depth in HA1, which is consistent with the level of the Avon River.

## 4.4 Site Subsoil Category

We consider that the site is a Class D deep soil site as defined by NZS 1170.5 (2004) "Structural Design Actions: Part 5: Earthquake actions – New Zealand".

Assuming a building importance level of 2, the following peak ground accelerations are considered appropriate for seismic analyses and design:

| | |
|---|---|
| Ultimate Limit State event: | 0.34g |
| Serviceability Limit State: | 0.11g |

Note that the SLS value has been calculated using a risk factor ($R_s$) of 0.33.

The following earthquake magnitudes are estimated[1] from the peak ground accelerations assuming rupture on a fault line beneath the Port Hills, some 10km to the southeast of the site.

| | |
|---|---|
| Ultimate Limit State event: | M 6.6 |
| Serviceability Limit State: | M 5.1 |

# 5 Ground Deformation Potential

## 5.1 Liquefaction Potential and Resultant Deformations

Analyses have been carried out using specialist software to determine what material layers beneath the site are likely to be prone to liquefaction under ULS and SLS design conditions, the resultant potential settlement at the surface due to consolidation of the liquefied sand layers, possible dry settlement due to shaking, building settlement due to the potential loss of ground bearing capacity as a result of the liquefaction of the near surface soils, and the potential for sand boil development at the surface. A review of the layers that are likely to have liquefied during the 22 February and 13 June 2011 earthquake events was also carried out using measured peak ground acceleration data.

### 5.1.1 Layers Subject to Liquefaction

**SLS Conditions**

No liquefaction is predicted to occur under SLS seismic loads.

**ULS Conditions**

[1] Estimation using chart in Youd, Leslie, and Bartlett (2002) "Revised Multilinear Regression Equations for Prediction of Lateral Spread Displacement"

The analyses show that a layer of loose silty sand immediately below the water table and above the very dense sand layer are likely to liquefy during a ULS earthquake (Figure 4). This is expected to be the layer that liquefied during the February 22 event.

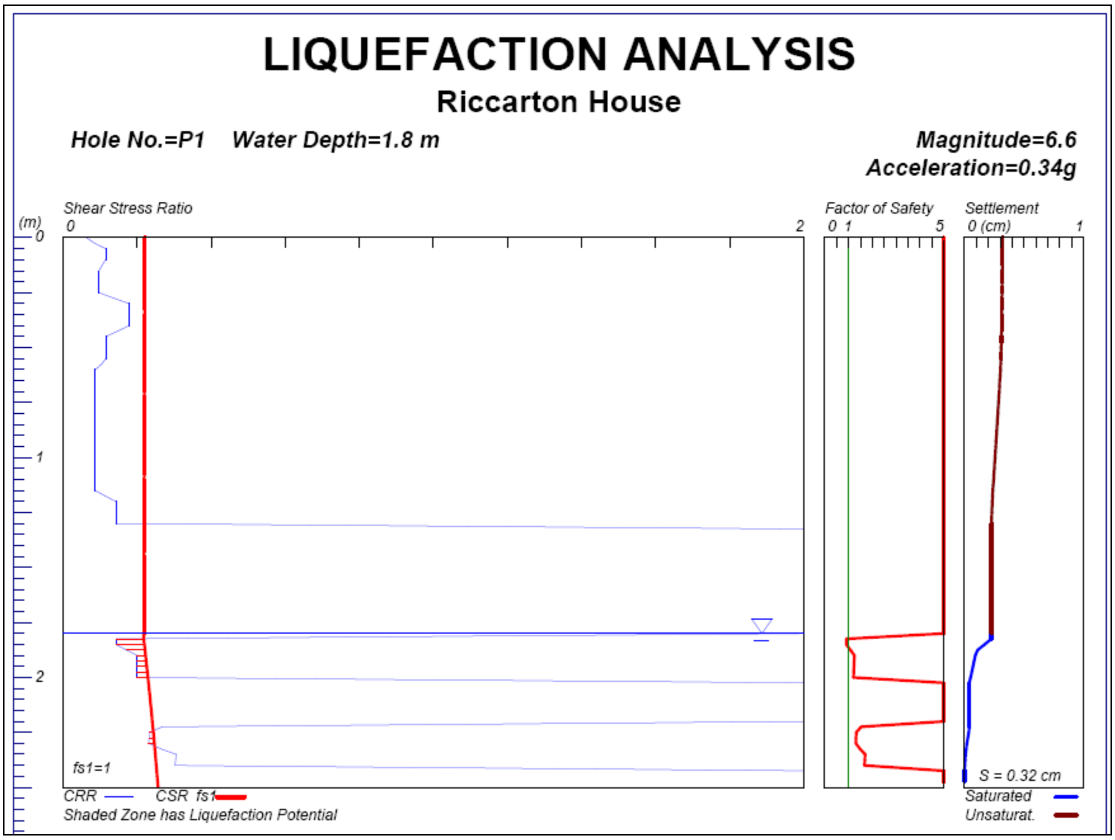



Figure 4: Liquefaction potential of the near surface soils beneath bay window area (ULS model).

### 5.1.2 Surface Settlement due to Liquefaction and Dry Settlement

**Serviceability Limit State Conditions**

No settlement is predicted to occur as result of a SLS earthquake event.

**Ultimate Limit State Conditions**

Negligible settlement is predicted to occur for this condition (3mm).

### 5.1.3 Building Settlement due to Loss of Bearing Capacity

The potential for punching failure or settlement of the building foundations due to liquefaction of the ground from 1.6m depth beneath the building has been assessed for each seismic condition. A footing width of 0.3m has been assumed, as has an undrained shear strength of the liquefied layers of 15kPa estimated using the Seed and Harder (1990) methedology.

**SLS conditions**

Building settlement due to a loss of ground strength beneath the foundations or punching shear failure is not expected under SLS seismic conditions.

**ULS Conditions**

The analyses indicate that an allowable bearing capacity of at least 70kPa is available during a ULS seismic event and as such bearing capacity failure due to liquefaction is not expected.

### 5.1.4 Sand Boil Potential

No sand boiling is expected for given the thin nature of the layer prone to liquefaction and the thickness of the covering soils.

## 5.2 Lateral Spreading Potential

Yielding of the river bank slope shows that the property was affected by lateral spreading following the February earthquake event, although this appears to be restricted to the area up to the footpath along the northern side of the building within 10m of the stream. A small tension crack <5mm in width was found to pass through the bay window indicating that very minor lateral spreading occurred beneath the building itself.

Analyses carried out to determine the potential for lateral spreading following a ULS earthquake indicate that a permanent displacement of 45mm at the front of the building and 35mm at the rear could occur. This is a net extension of 10mm across the building footprint.

## 5.3 Compressible Ground and Consolidation Settlement

Low strength or compressible ground that may result in consolidation settlement with loading was identified beneath the bay window area.

## 5.4 Ground Shrinkage and Swelling Potential

The near surface soils appear to be slightly plastic only with a liquid limit below 50% based on their physical characteristics determined during testing. We consider that the effects of soil shrinkage and swelling on the foundations due to seasonal changes in soil moisture is unlikely to occur.

# 6 ENGINEERING RECOMMENDATIONS

## 6.1 Strip and Pad Footings

Should replacement strip or pad footings be considered, we make the following recommendations:

**Depth**

For design we recommend strip footings and any pad footings for the eastern wing be taken to a depth of 0.4m depth.

**Bearing Capacity**

At that depth geotechnical ultimate, factored (ULS, $\Phi$=0.5) and allowable (FoS=3) bearing capacities of 210kPa, 140kPa and 70kPa respectively is considered to be available.

## 6.2 Verification Checks

Verification testing of the ground by a Christchurch City Council Building Inspector or Suitably Qualified Professional is recommended to ensure that the ground conditions at the base of the foundation excavations are as described in this report, and that all unsuitable and loose materials have been removed. We should be contacted immediately if these conditions vary from that described in this report. A modification to the recommendations or design may be required.

# 7 OTHER CONSIDERATIONS

This report has been prepared exclusively for Insight Unlimited on behalf of the Christchurch City Council with respect to the particular brief given to us. Information, opinions and recommendations contained in it can not be used for any other purpose or by any other entity without our review and written consent. Land Development & Exploration Ltd accepts no liability or responsibility whatsoever for or in respect of any use or reliance upon this report by any third party.

Opinions given in this report are based on visual methods, and subsurface investigations at discrete locations. The nature and continuity of the subsurface materials between these locations are inferred and it must be appreciated that actual conditions could vary from that described herein. We should be contacted immediately if the conditions are found to differ from that described in this report.

Yours faithfully

LAND DEVELOPMENT & EXPLORATION LTD

Georg Winkler

*Geological & Geotechnical Engineer*

*MIPENZ, CPEng*

*Managing Director*

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# APPENDIX A

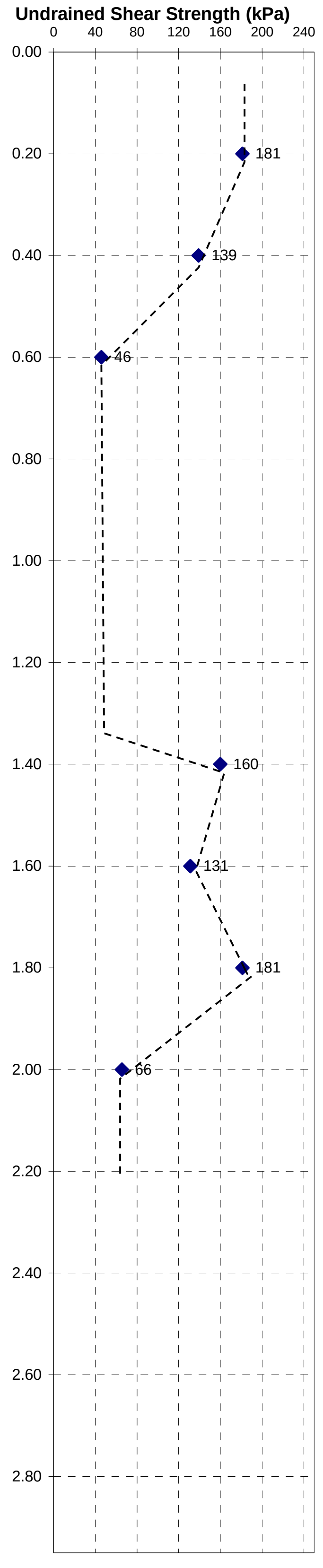
## SUBSURFACE INVESTIGATION DATA

# BOREHOLE LOG

**BOREHOLE No:** HA1

| | | | |
|---|---|---|---|
| **Client:** Christchurch City Council | **Project:** Geotechnical Investigation of Riccarton House | **LDE Project No.:** | 10048 |
| **Project Location:** 12 Kahu Road, Riccarton, Christchurch | **Borehole Location:** Refer to site plan | **Hole started:**<br>**Hole completed:** | 8/10/2011<br>8/10/2011 |
| **Co-ordinates:** mN mE | **Drill method:** 50mm handauger | **Drilled by:**<br>**Logged by:** | S. Bryant<br>S. Bryant |

| Depth (m) | Moisture | Strength | Soil Description | Geology |
|---|---|---|---|---|
| 0.00 | M | VSt | SILT, some clay, some fine sub-angular gravels, dark greyish brown, very stiff, moist | Weathered Alluvium |
| 0.20 | | | no clay, no gravel, light brown | |
| 0.50 | | | some fine sand | |
| 0.60 | M-W | L | SAND, fine, silty, greyish brown, loose, moist to wet | |
| 0.90 | W | | greyish brown to dark greyish brown, rare iron mottles, wet | |
| 1.10 | W-S | | clayey, light greyish brown, wet to saturated | |
| 1.30 | S | VSt | CLAY, silty, light greyish brown, abundant iron mottles, non-plastic, very stiff, wet to saturated | |
| 1.60 | | | low plasticity | |
| 1.80 | S | L-MD | SAND, fine, silty, greyish brown, loose to medium dense, saturated | |
| 2.00 | S | St | CLAY, grey, abundant iron mottles, low plasticity, stiff, saturated | |
| 2.20 | | L-MD | SAND, fine to medium grain, grey, loose to medium dense, saturated | |
| 2.45 | | VD | very dense | |
| 2.60 | | | End of borehole @ 2.6m | |
| 2.65 | | | Unable to continue due to gravel snapping auger | |
| 2.70 | | | Water table @ 1.8m | |



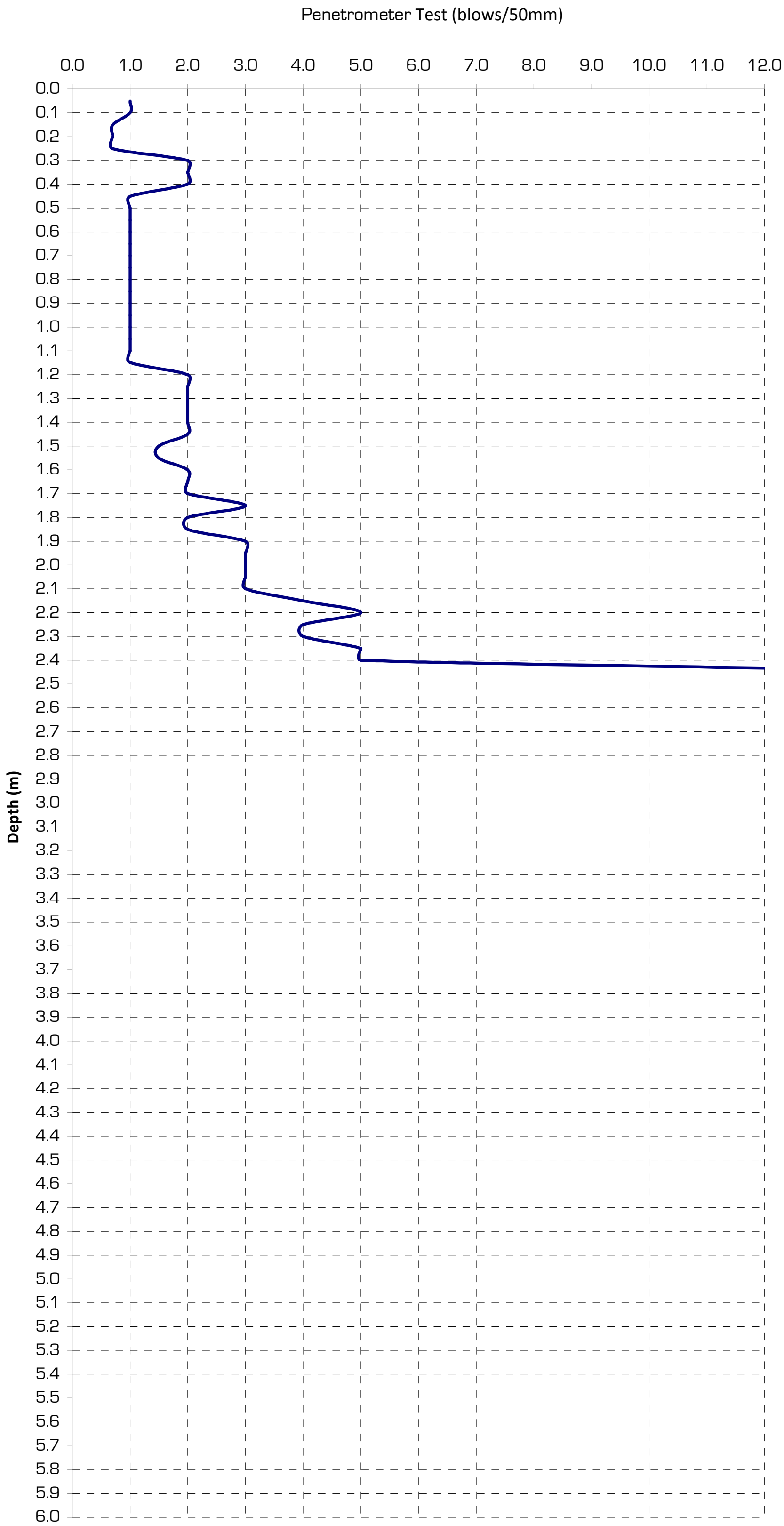

Notes: Shear strength lines are indicative only.
Shear strength calibrated and adjusted for plasticity

# PENETROMETER TEST LOG

| | | | |
|---|---|---|---|
| **Client:** Christchurch City Council | **Project:** Geotechnical Investigation of Riccarton House | **LDE Project No.:** | 10048 |
| **Project Location:** 12 Kahu Road, Riccartion, Christchurch | **Test Location:** Refer to site plan | **Test date:** | 10 August 2011 |
| **Co-ordinates:** mN mE | **Test method:** Dynamic Penetrometer | **Tested by:** | S. Bryant |

**PENETROMETER TEST No:** P1

| Depth (m) | Blows/50mm | Density | | Depth (m) | Blows/50mm | Density |
|---|---|---|---|---|---|---|
| 0.05 | 1.0 | L | | 3.00 | | |
| 0.10 | 1.0 | L | | 3.05 | | |
| 0.15 | 0.7 | VL | | 3.10 | | |
| 0.20 | 0.7 | VL | | 3.15 | | |
| 0.25 | 0.7 | VL | | 3.20 | | |
| 0.30 | 2.0 | L | | 3.25 | | |
| 0.35 | 2.0 | L | | 3.30 | | |
| 0.40 | 2.0 | L | | 3.35 | | |
| 0.45 | 1.0 | L | | 3.40 | | |
| 0.50 | 1.0 | L | | 3.45 | | |
| 0.55 | 1.0 | L | | 3.50 | | |
| 0.60 | 1.0 | L | | 3.55 | | |
| 0.65 | 1.0 | L | | 3.60 | | |
| 0.70 | 1.0 | L | | 3.65 | | |
| 0.75 | 1.0 | L | | 3.70 | | |
| 0.80 | 1.0 | L | | 3.75 | | |
| 0.85 | 1.0 | L | | 3.80 | | |
| 0.90 | 1.0 | L | | 3.85 | | |
| 0.95 | 1.0 | L | | 3.90 | | |
| 1.00 | 1.0 | L | | 3.95 | | |
| 1.05 | 1.0 | L | | 4.00 | | |
| 1.10 | 1.0 | L | | 4.05 | | |
| 1.15 | 1.0 | L | | 4.10 | | |
| 1.20 | 2.0 | L | | 4.15 | | |
| 1.25 | 2.0 | L | | 4.20 | | |
| 1.30 | 2.0 | L | | 4.25 | | |
| 1.35 | 2.0 | L | | 4.30 | | |
| 1.40 | 2.0 | L | | 4.35 | | |
| 1.45 | 2.0 | L | | 4.40 | | |
| 1.50 | 1.5 | L | | 4.45 | | |
| 1.55 | 1.5 | L | | 4.50 | | |
| 1.60 | 2.0 | L | | 4.55 | | |
| 1.65 | 2.0 | L | | 4.60 | | |
| 1.70 | 2.0 | L | | 4.65 | | |
| 1.75 | 3.0 | L-MD | | 4.70 | | |
| 1.80 | 2.0 | L | | 4.75 | | |
| 1.85 | 2.0 | L | | 4.80 | | |
| 1.90 | 3.0 | L-MD | | 4.85 | | |
| 1.95 | 3.0 | L-MD | | 4.90 | | |
| 2.00 | 3.0 | L-MD | | 4.95 | | |
| 2.05 | 3.0 | L-MD | | 5.00 | | |
| 2.10 | 3.0 | L-MD | | 5.05 | | |
| 2.15 | 4.0 | L-MD | | 5.10 | | |
| 2.20 | 5.0 | MD | | 5.15 | | |
| 2.25 | 4.0 | L-MD | | 5.20 | | |
| 2.30 | 4.0 | L-MD | | 5.25 | | |
| 2.35 | 5.0 | MD | | 5.30 | | |
| 2.40 | 5.0 | MD | | 5.35 | | |
| 2.45 | 15.0 | VD | | 5.40 | | |
| 2.50 | 14.0 | VD | | 5.45 | | |
| 2.55 | | | | 5.50 | | |
| 2.60 | | | | 5.55 | | |
| 2.65 | | | | 5.60 | | |
| 2.70 | | | | 5.65 | | |
| 2.75 | | | | 5.70 | | |
| 2.80 | | | | 5.75 | | |
| 2.85 | | | | 5.80 | | |
| 2.90 | | | | 5.85 | | |
| 2.95 | | | | 5.90 | | |




| | |
|---|---|
| (red) | Very low strength ground <1 blow per 50mm |
| (orange) | Low strength ground 1 to 2 blows per 50mm |
| (green) | Ground with ultimate bearing capacity of at least 300kPa |

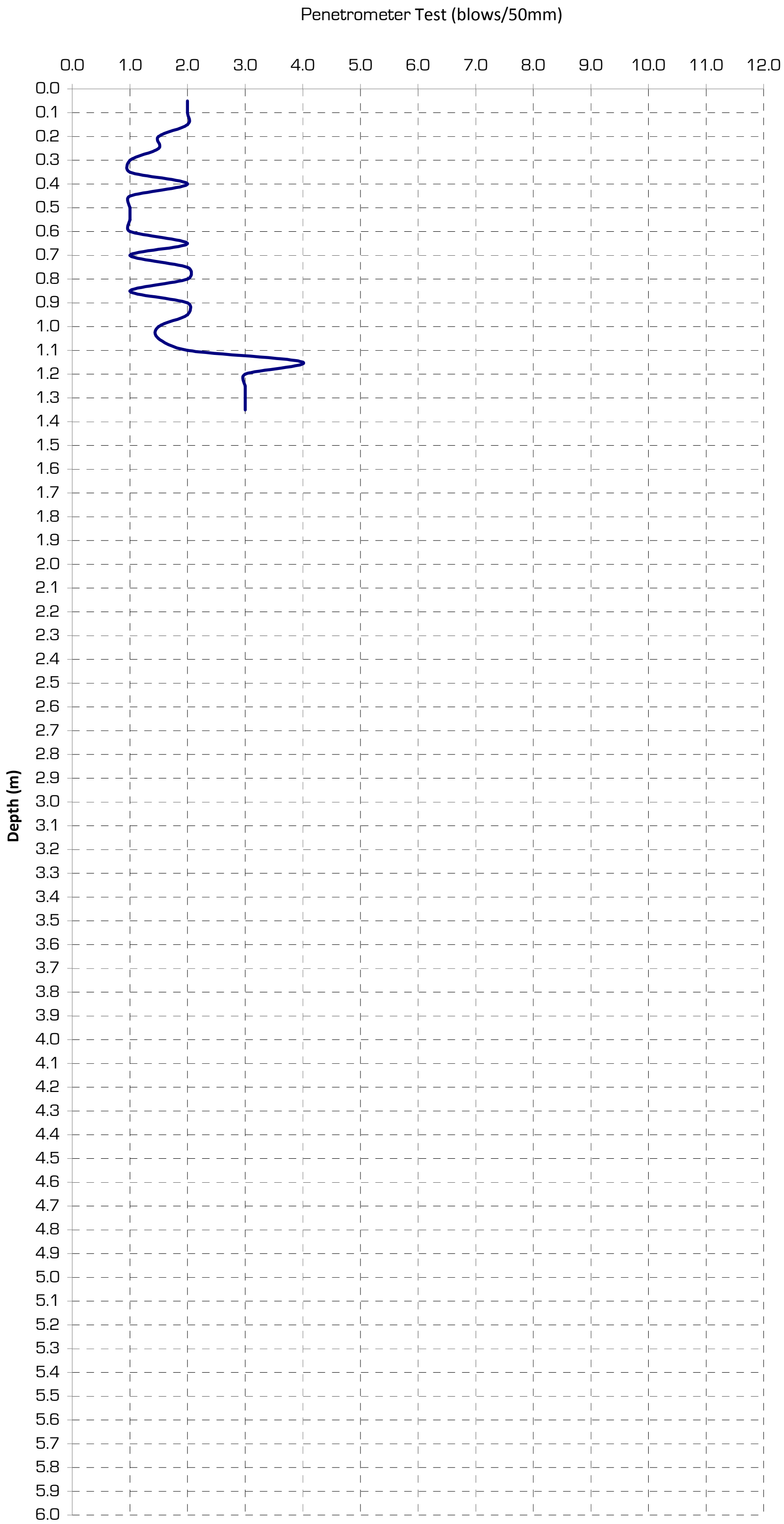
Notes: Density classification based on NZ Geotechnical Society Field Description for Soil and Rock
Effective friction angles are indicative only and are based on SPT-penetrometer correlations
Strength chart indicative only
Refer to plan for test site locations
Information is taken from point locations. Ground conditions may vary from that shown away from test site.
Low strength layers which are thinner than 50mm may exist which are not shown.

# PENETROMETER TEST LOG

| PENETROMETER TEST No: | P2 |
|---|---|

| | | | |
|---|---|---|---|
| **Client:** Christchurch City Council | **Project:** Geotechnical Investigation of Riccarton House | **LDE Project No.:** | 10048 |
| **Project Location:** 12 Kahu Road, Riccartion, Christchurch | **Test Location:** Refer to site plan | **Test date:** | 10 August 2011 |
| **Co-ordinates:** mN mE | **Test method:** Dynamic Penetrometer | **Tested by:** | S. Bryant |

| Depth (m) | Blows/50mm | Density | Depth (m) | Blows/50mm | Density |
|---|---|---|---|---|---|
| 0.05 | 2.0 | L | 3.00 | | |
| 0.10 | 2.0 | L | 3.05 | | |
| 0.15 | 2.0 | L | 3.10 | | |
| 0.20 | 1.5 | L | 3.15 | | |
| 0.25 | 1.5 | L | 3.20 | | |
| 0.30 | 1.0 | L | 3.25 | | |
| 0.35 | 1.0 | L | 3.30 | | |
| 0.40 | 2.0 | L | 3.35 | | |
| 0.45 | 1.0 | L | 3.40 | | |
| 0.50 | 1.0 | L | 3.45 | | |
| 0.55 | 1.0 | L | 3.50 | | |
| 0.60 | 1.0 | L | 3.55 | | |
| 0.65 | 2.0 | L | 3.60 | | |
| 0.70 | 1.0 | L | 3.65 | | |
| 0.75 | 2.0 | L | 3.70 | | |
| 0.80 | 2.0 | L | 3.75 | | |
| 0.85 | 1.0 | L | 3.80 | | |
| 0.90 | 2.0 | L | 3.85 | | |
| 0.95 | 2.0 | L | 3.90 | | |
| 1.00 | 1.5 | L | 3.95 | | |
| 1.05 | 1.5 | L | 4.00 | | |
| 1.10 | 2.0 | L | 4.05 | | |
| 1.15 | 4.0 | L-MD | 4.10 | | |
| 1.20 | 3.0 | L-MD | 4.15 | | |
| 1.25 | 3.0 | L-MD | 4.20 | | |
| 1.30 | 3.0 | L-MD | 4.25 | | |
| 1.35 | 3.0 | L-MD | 4.30 | | |
| 1.40 | | | 4.35 | | |
| 1.45 | | | 4.40 | | |
| 1.50 | | | 4.45 | | |
| 1.55 | | | 4.50 | | |
| 1.60 | | | 4.55 | | |
| 1.65 | | | 4.60 | | |
| 1.70 | | | 4.65 | | |
| 1.75 | | | 4.70 | | |
| 1.80 | | | 4.75 | | |
| 1.85 | | | 4.80 | | |
| 1.90 | | | 4.85 | | |
| 1.95 | | | 4.90 | | |
| 2.00 | | | 4.95 | | |
| 2.05 | | | 5.00 | | |
| 2.10 | | | 5.05 | | |
| 2.15 | | | 5.10 | | |
| 2.20 | | | 5.15 | | |
| 2.25 | | | 5.20 | | |
| 2.30 | | | 5.25 | | |
| 2.35 | | | 5.30 | | |
| 2.40 | | | 5.35 | | |
| 2.45 | | | 5.40 | | |
| 2.50 | | | 5.45 | | |
| 2.55 | | | 5.50 | | |
| 2.60 | | | 5.55 | | |
| 2.65 | | | 5.60 | | |
| 2.70 | | | 5.65 | | |
| 2.75 | | | 5.70 | | |
| 2.80 | | | 5.75 | | |
| 2.85 | | | 5.80 | | |
| 2.90 | | | 5.85 | | |
| 2.95 | | | 5.90 | | |




Notes: Density classification based on NZ Geotechnical Society Field Description for Soil and Rock
Effective friction angles are indicative only and are based on SPT-penetrometer correlations
Strength chart indicative only
Refer to plan for test site locations
Information is taken from point locations. Ground conditions may vary from that shown away from test site.
Low strength layers which are thinner than 50mm may exist which are not shown.

- (red) Very low strength ground <1 blow per 50mm
- (orange) Low strength ground 1 to 2 blows per 50mm
- (green) Ground with ultimate bearing capacity of at least 300kPa

# APPENDIX B

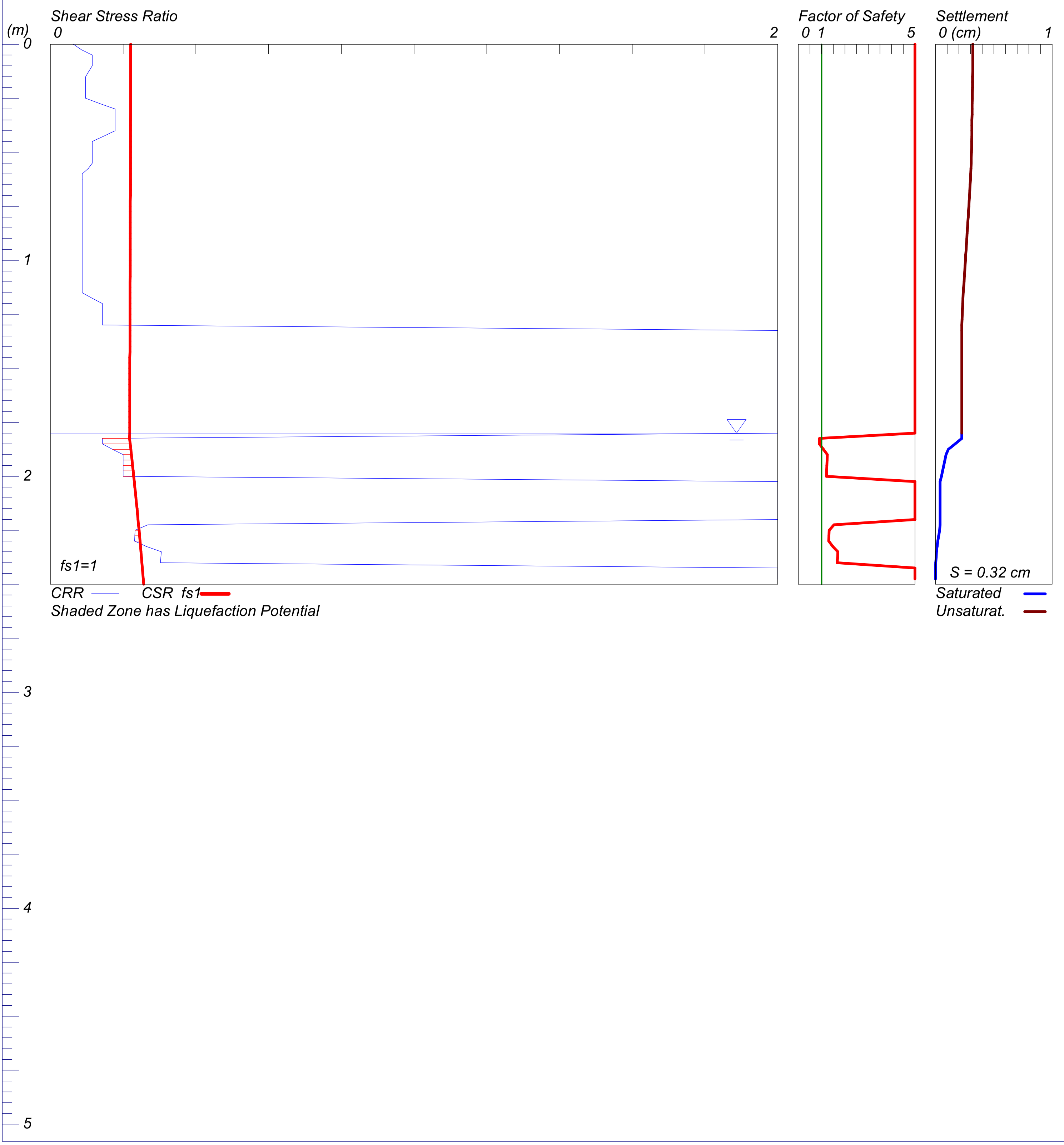
# ANALYSIS PRINTOUTS

# LIQUEFACTION ANALYSIS

## Riccarton House

***Hole No.=P1 Water Depth=1.8 m***

***Magnitude=6.6***
***Acceleration=0.34g***

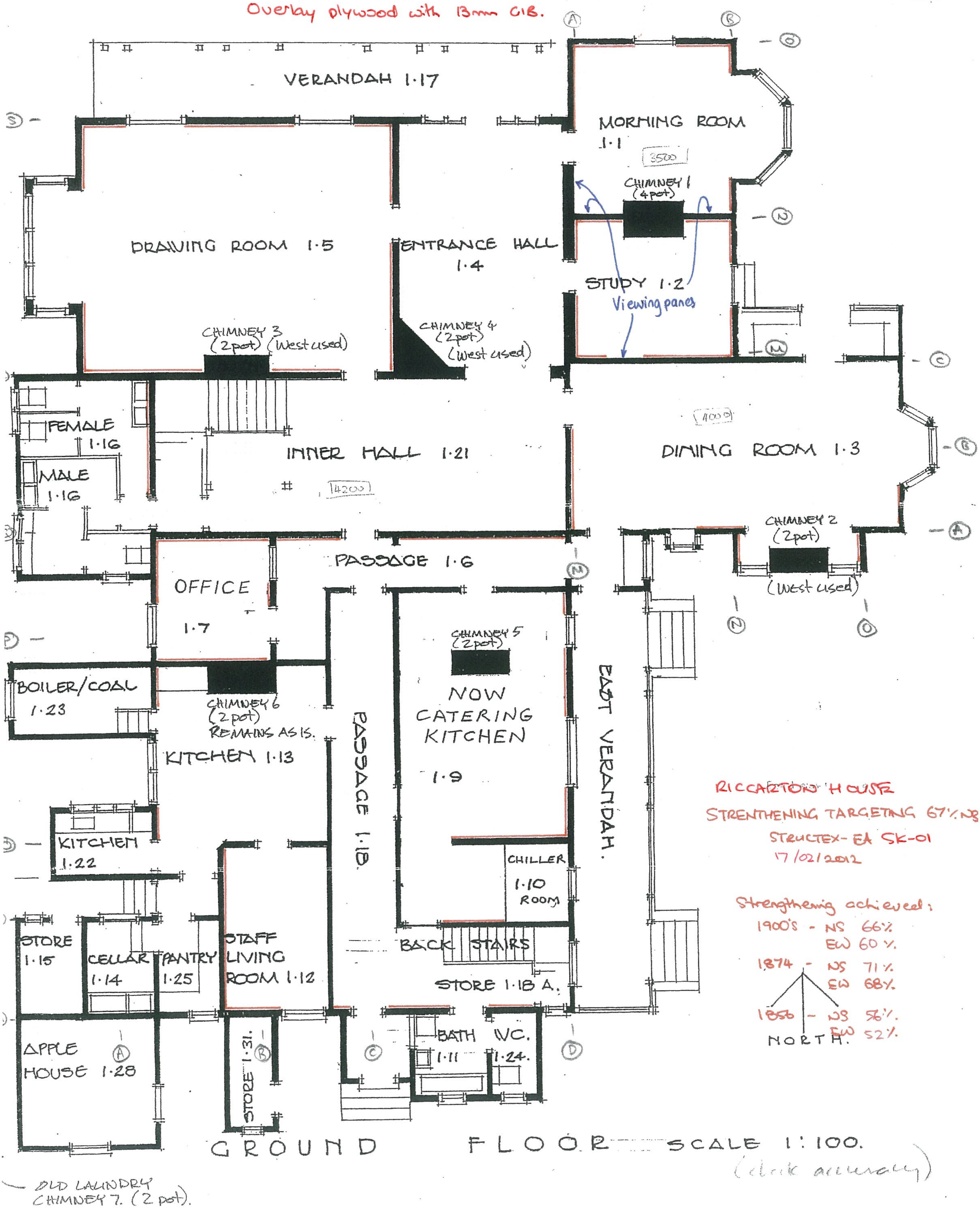



LiquefyPro CivilTech Software USA www.civiltech.com

**Plate A-1**

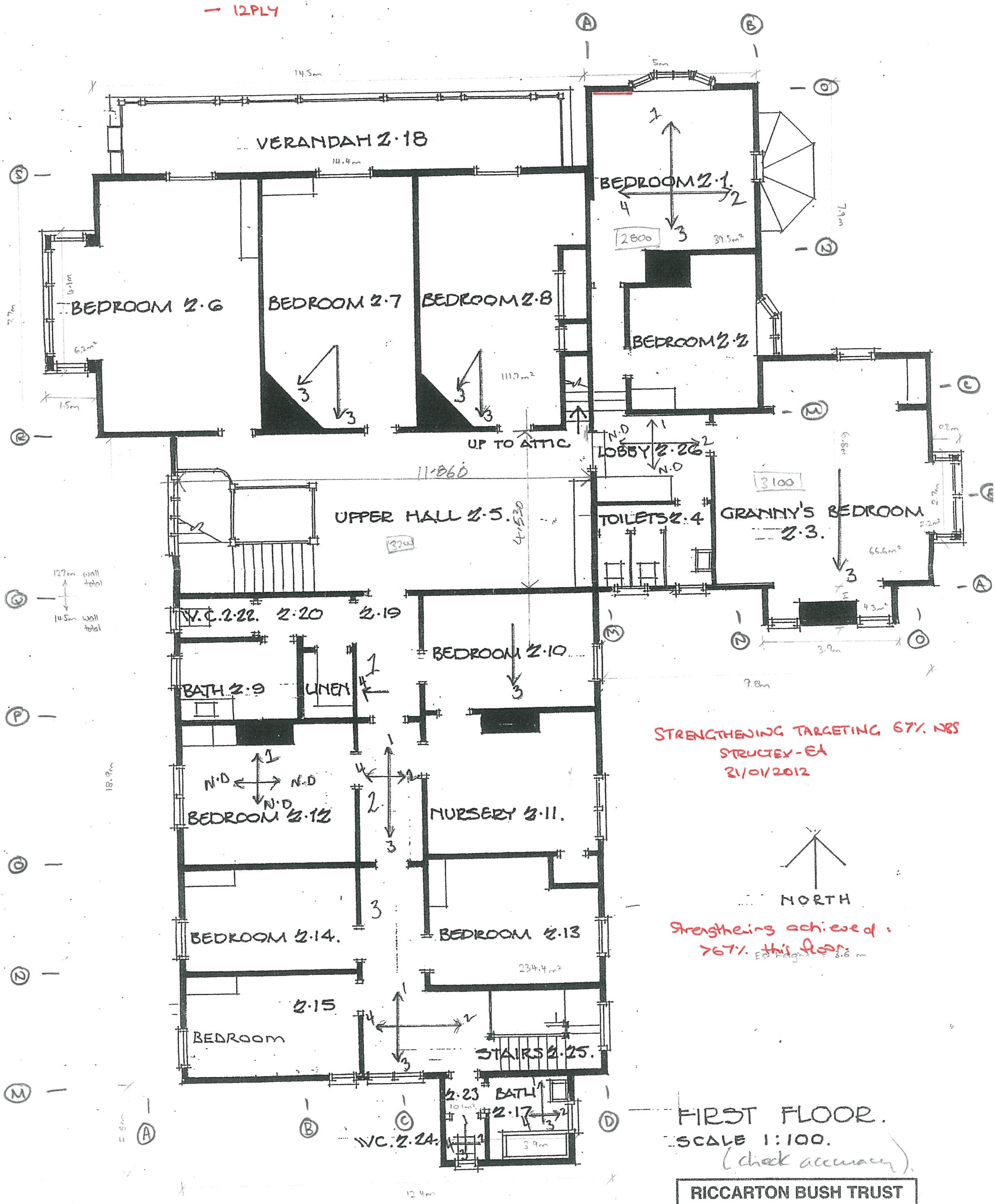
## Appendix E: Proposed strengthening work to 67%NBS

— 12mm H1.2 structural bracing plywood. Fix to studs, dwangs and plates with Ø3.15 x 45mm flat head nails at 100mm crs to sheet perimeter, and at 300mm crs elsewhere. All other fixing details (e.g. edge requirements) to comply with ecoply literature. Provide GIB Handibrac panel holddowns to bottom corners. Overlay plywood with 13mm GIB.



*N·D = NO DAMAGE

— 12PLY

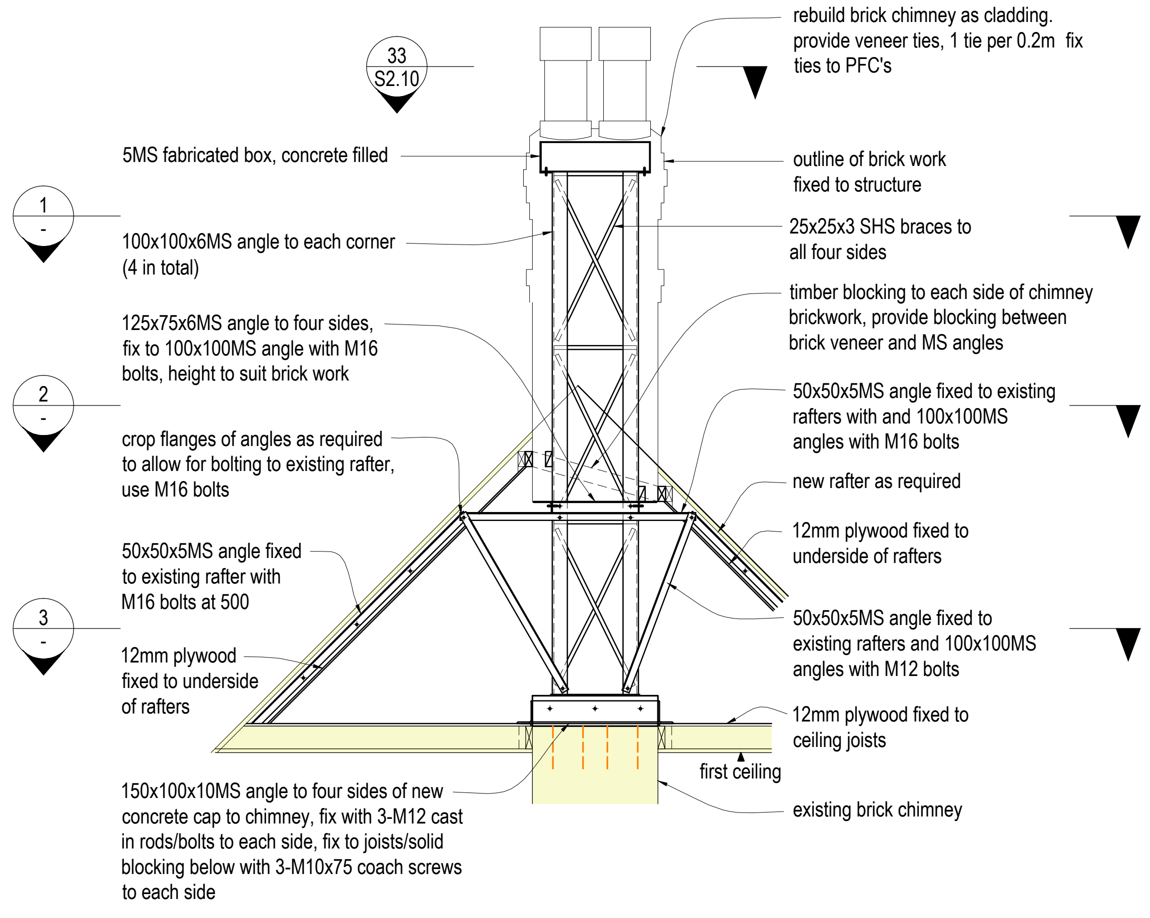



STRENGTHENING TARGETING 67% NBS
STRUCTEX - EA
31/01/2012

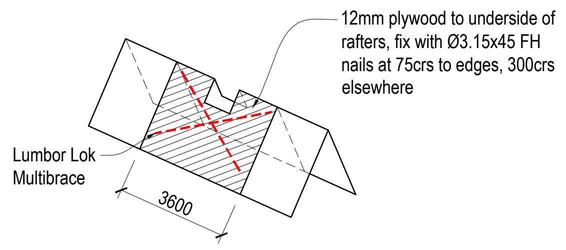
Strengthening achieved: >67% this floor.

FIRST FLOOR.
SCALE 1:100.
(check accuracy)

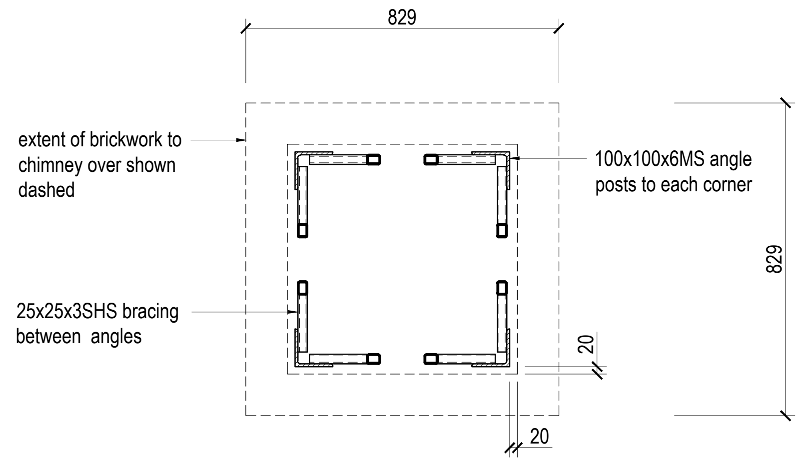
RICCARTON BUSH TRUST
P.O. BOX 8276 CHRISTCHURCH
PHONE 341 1018 FAX 341 6839



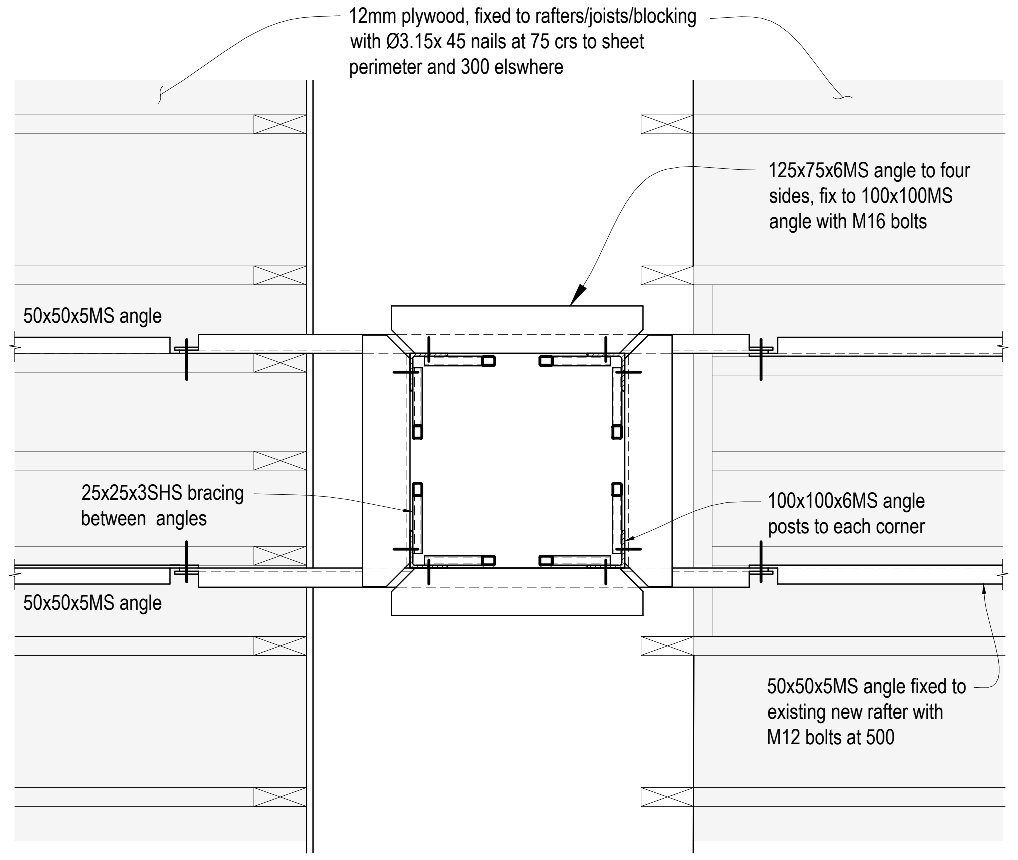

FRONT ELEVATION TO CHIMNEY 1
Scale: 1:50




extent of plwood linings to rafters




1 SECTION -
Scale: 1:20

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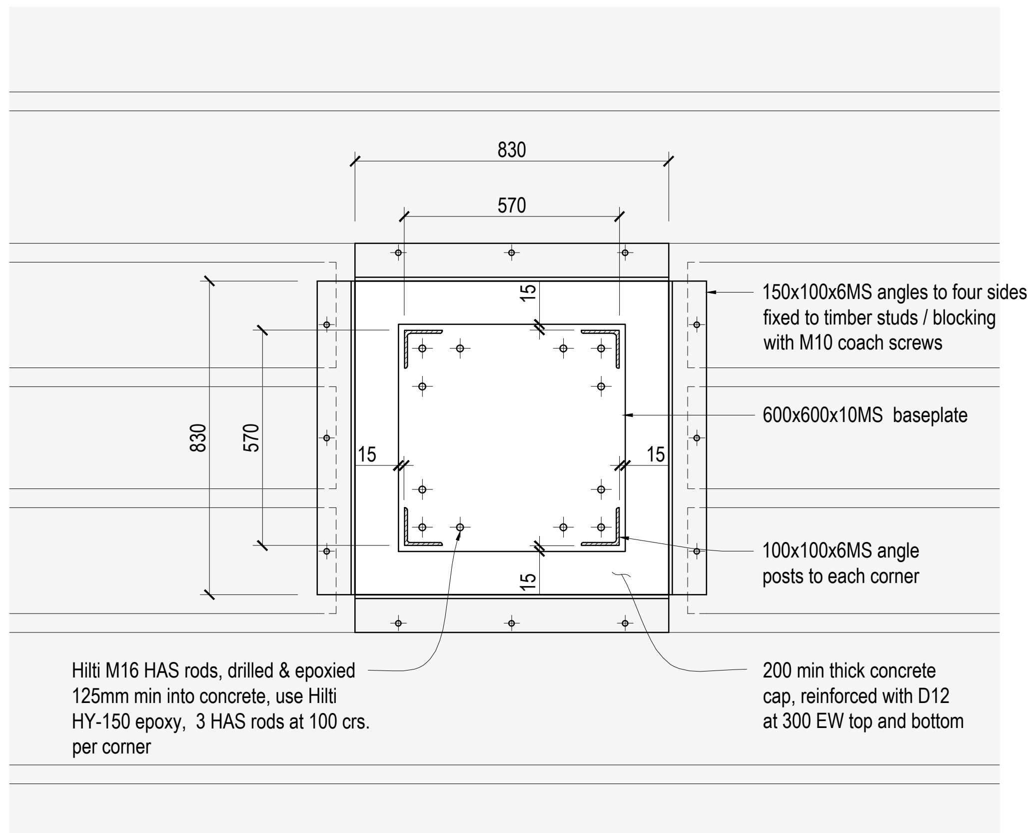
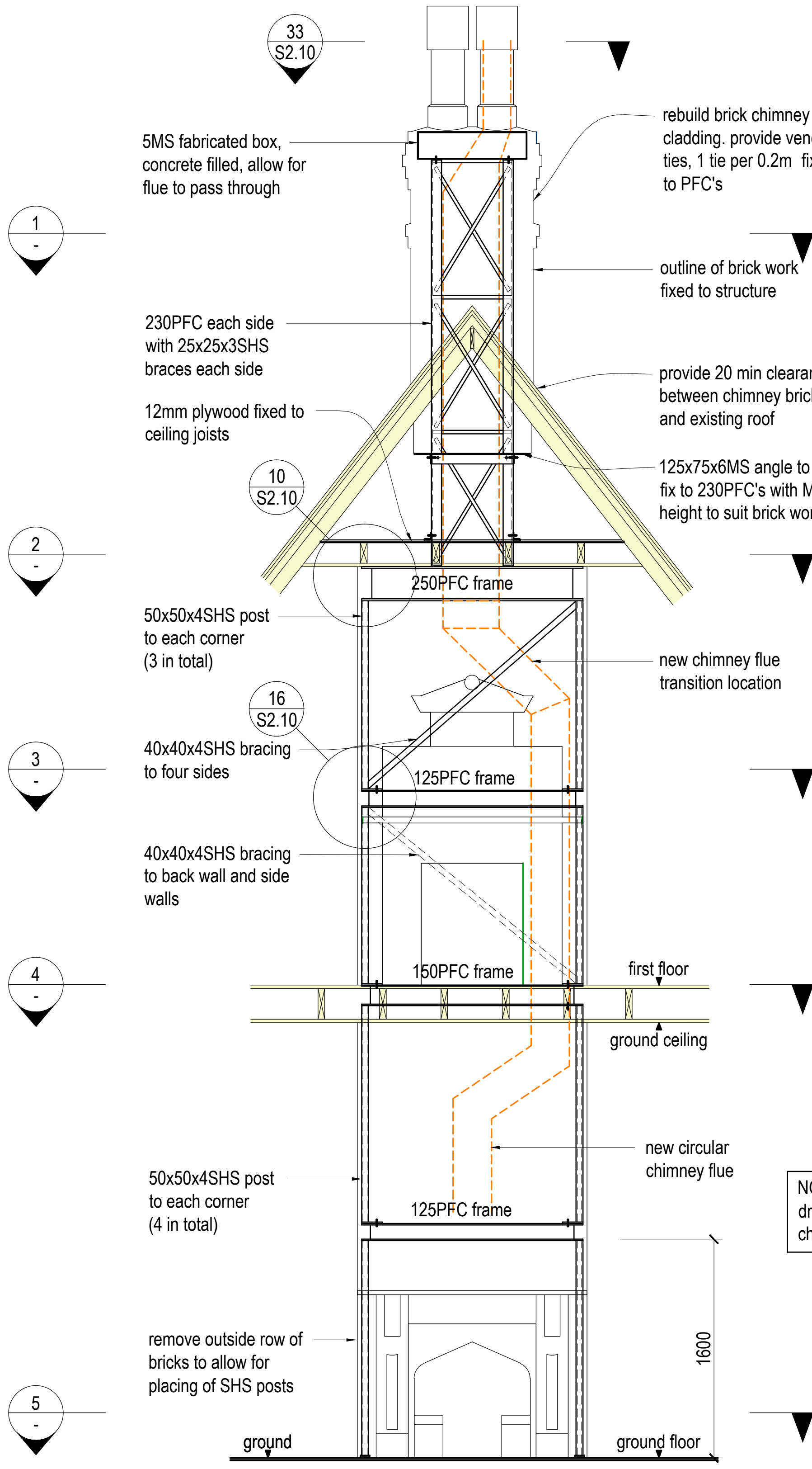



3 SECTION -
Scale: 1:20

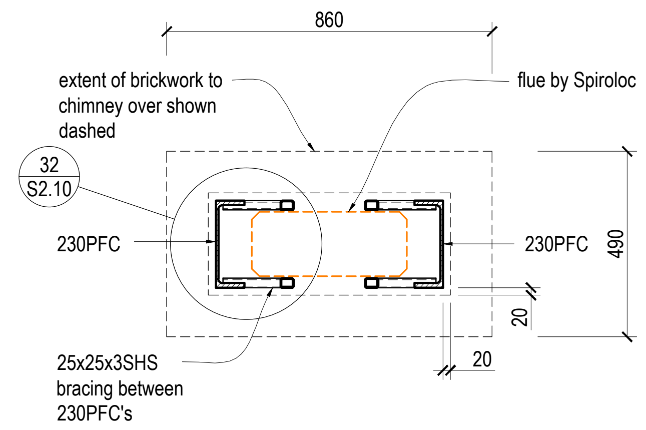
GENERAL NOTES:
1. Detailed plans are orientated with north looking up the page and therefore may not necessary correspond with the Front Elevation
2. All dimensions shown are to be confirmed on site and with the Architects drawings

| issue | description | by | appd. | date | drawn | designed | approved | scales | client | project title | | drawing title | drawing no | project / issue |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | DM | EA | | 1:50<br>1:20 | INSIGHT UNLIMITED | RICCARTON HOUSE<br>16 KAHU ROAD | structex<br>"Giving support a whole new meaning" www.structex.co.nz | CHIMNEY NUMBER 1 | S2.01 | 5906<br>A |

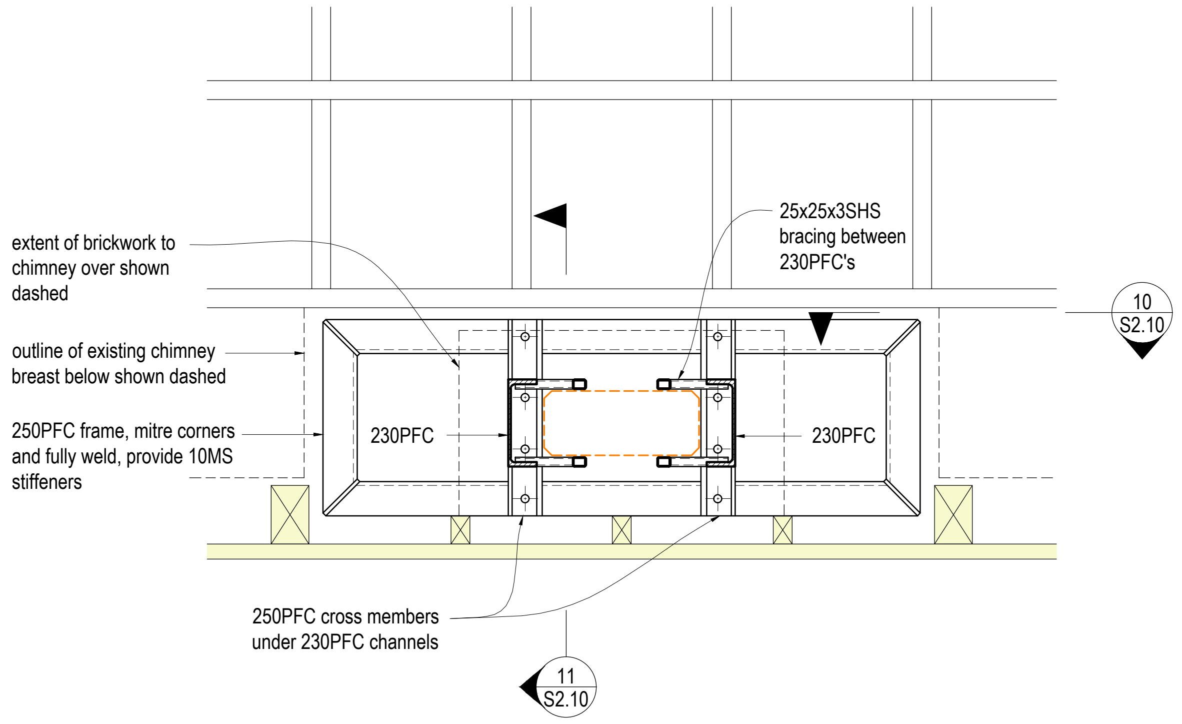
 P:\PROJECTS\5906\D\CHIMNEYS.DWG 10/10/11 12:08 A2 ORIGINAL



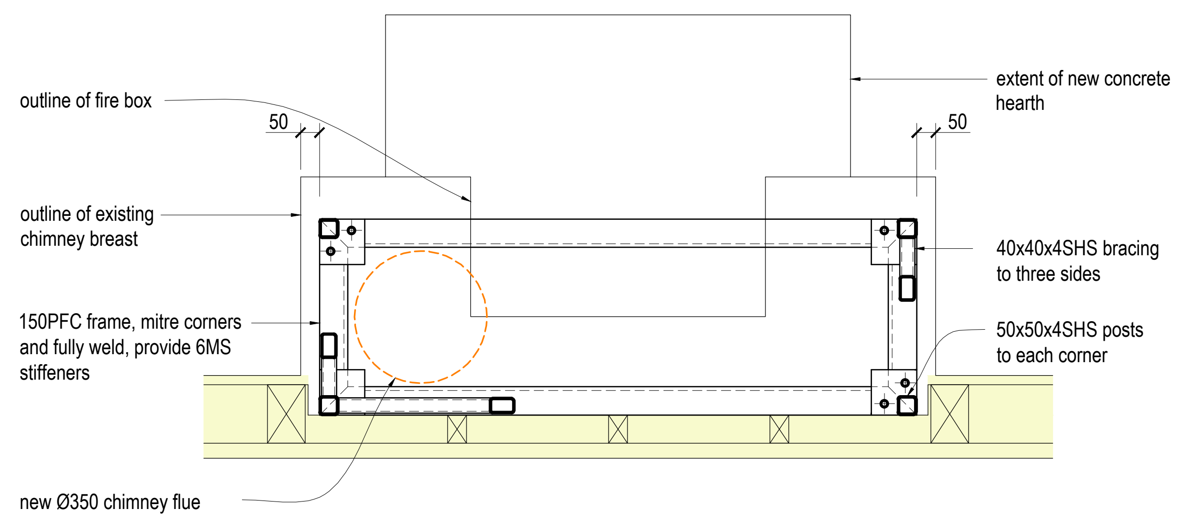

FRONT ELEVATION TO CHIMNEY 2
Scale: 1:50



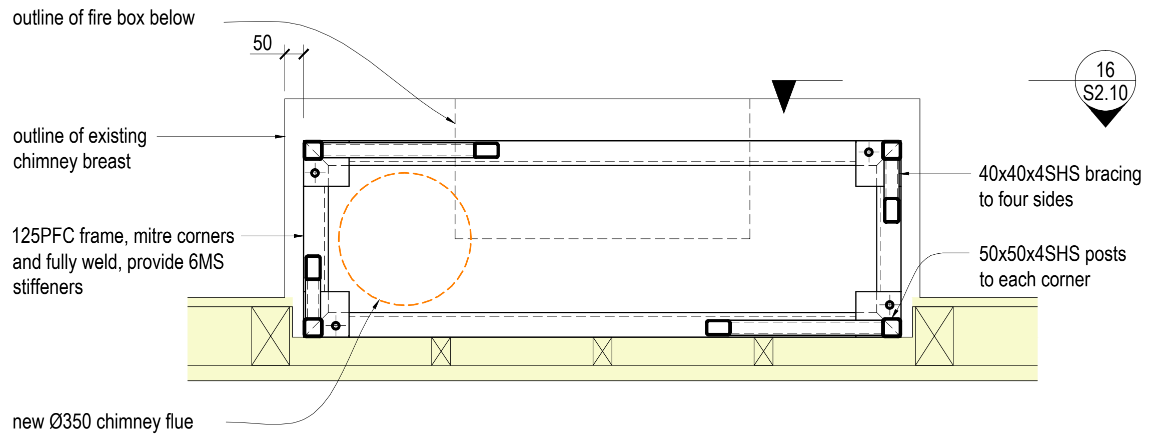

1 SECTION -
Scale: 1:20



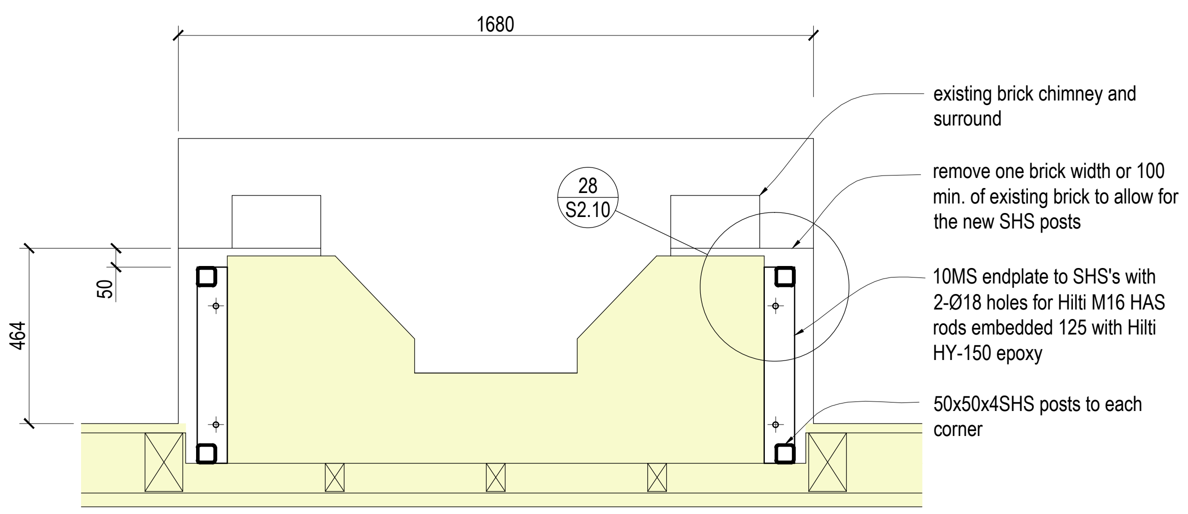

2 SECTION -
Scale: 1:20




4 SECTION -
Scale: 1:20




3 SECTION -
Scale: 1:20

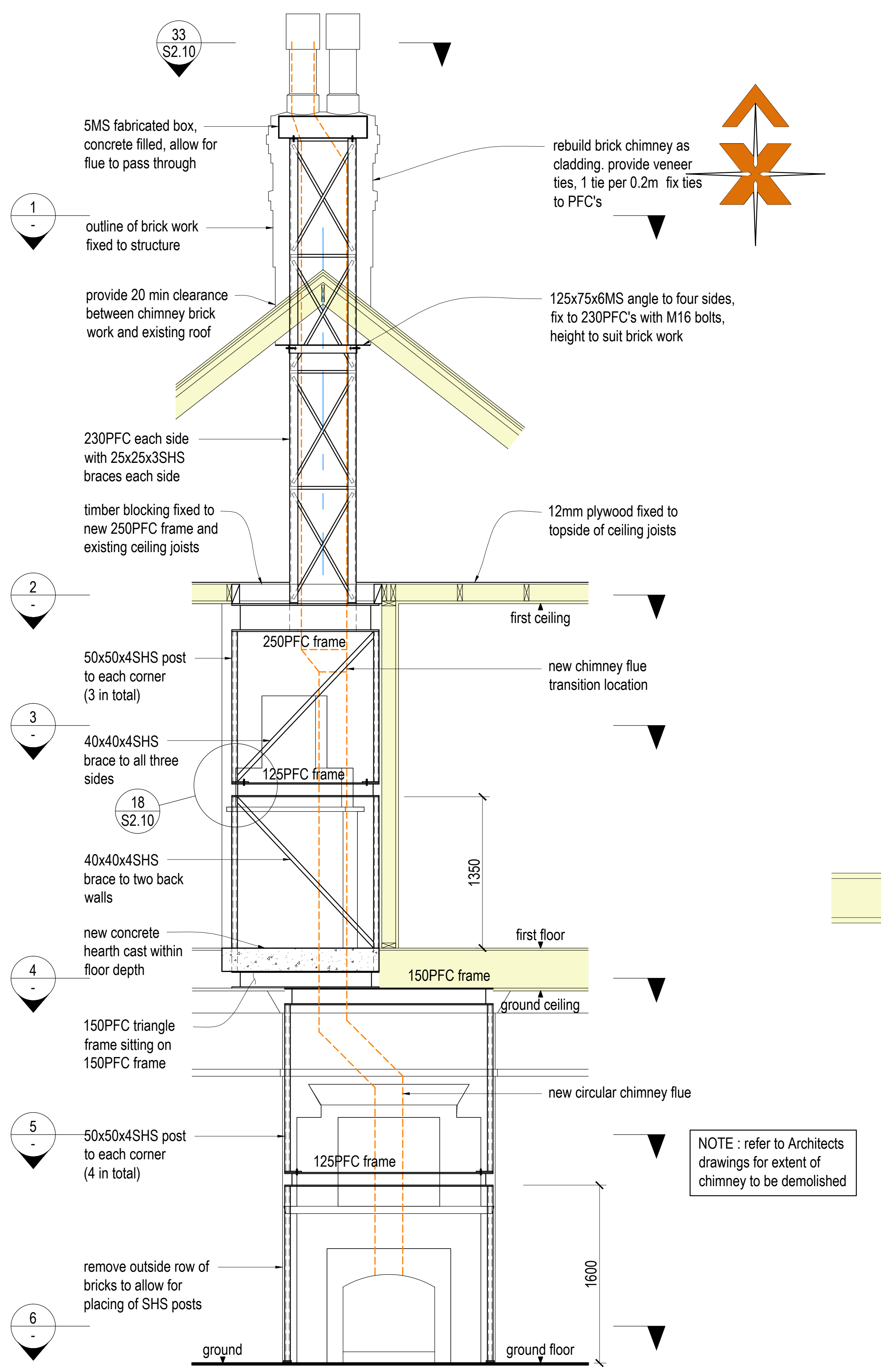



5 SECTION -
Scale: 1:20

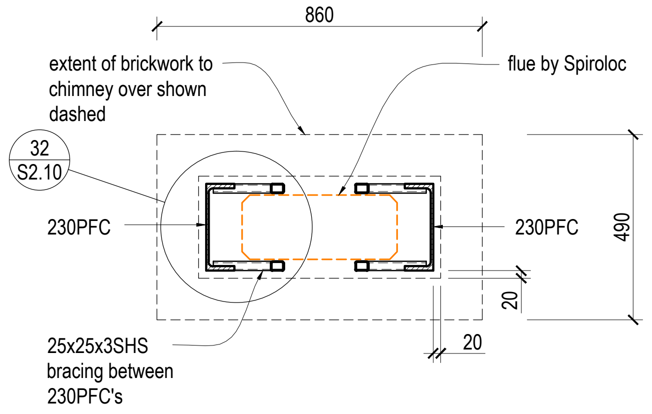
GENERAL NOTES:

1. Detailed plans are orientated with north looking up the page and therefore may not necessary correspond with the Front Elevation
2. All dimensions shown are to be confirmed on site and with the Architects drawings

| issue | description | by | appd. | date | drawn | designed | approved | scales | client | project title | | drawing title | drawing no | project / issue |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | DM | EA | | 1:50<br>1:20 | INSIGHT UNLIMITED | RICCARTON HOUSE<br>16 KAHU ROAD | structex<br>"Giving support a whole new meaning" www.structex.co.nz | CHIMNEY NUMBER 2 | S2.02 | 5906<br>A |



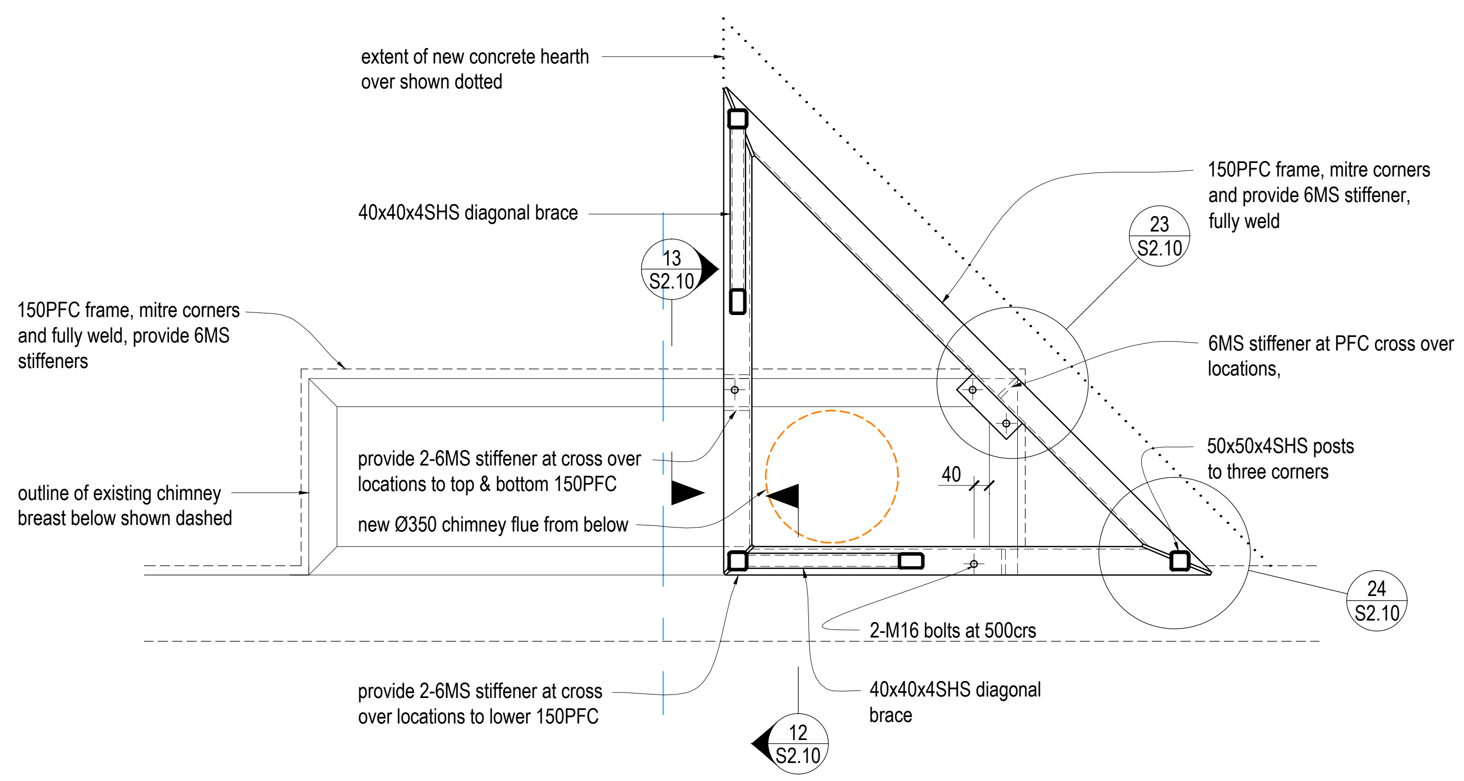

FRONT ELEVATION TO CHIMNEY 3
Scale: 1:50



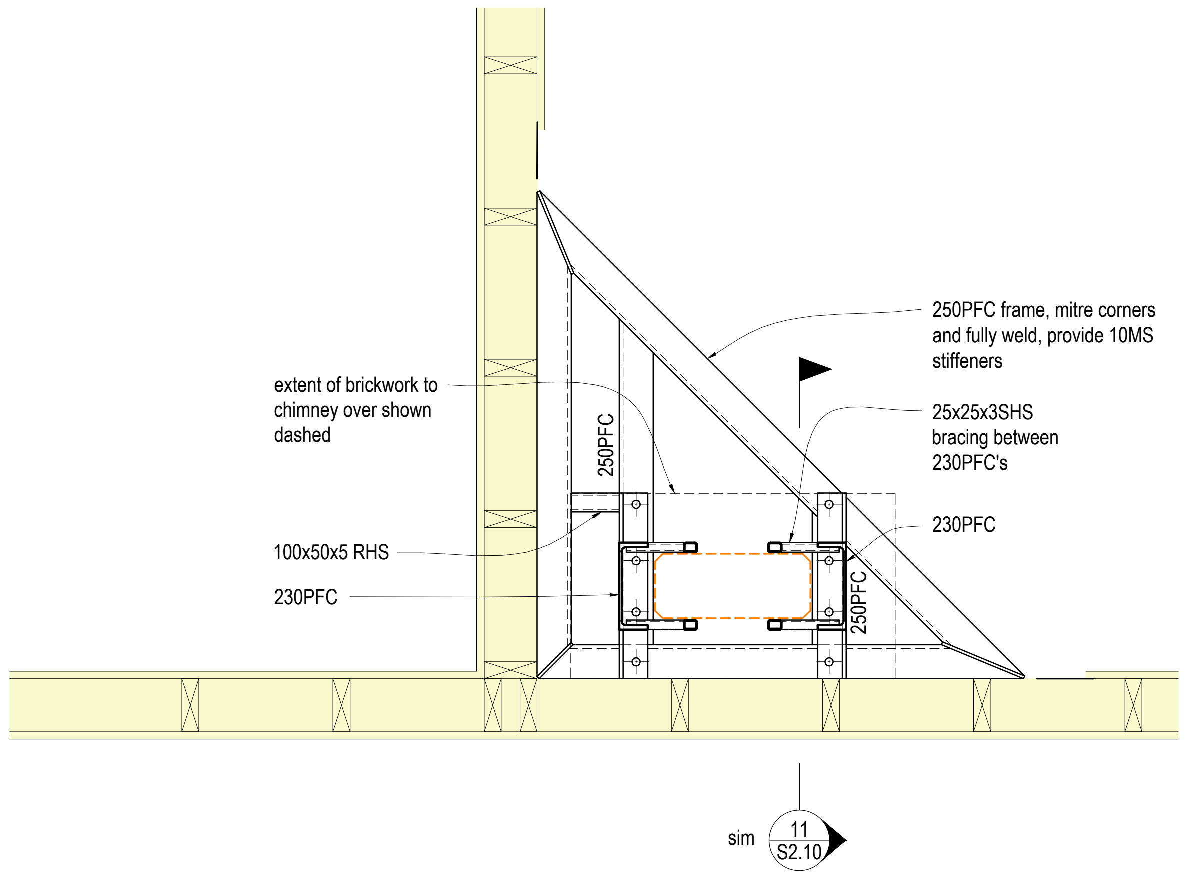

SECTION 1 -
Scale: 1:20

GENERAL NOTES

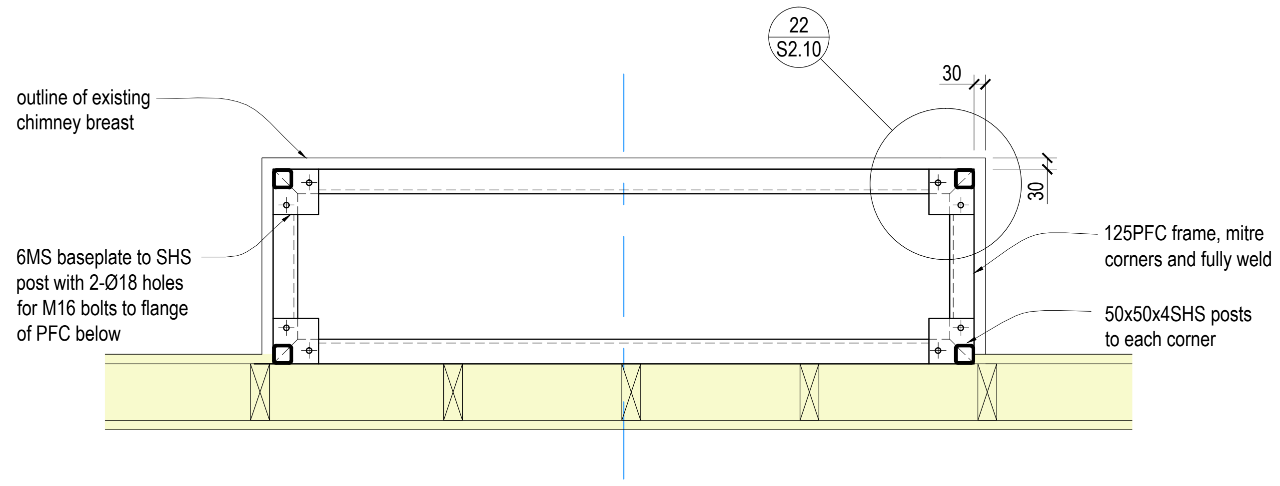
1. Detailed plans are orientated with north looking up the page and therefore may not necessary correspond with the Front Elevation
2. All dimensions shown are to be confirmed on site and with the Architects drawings



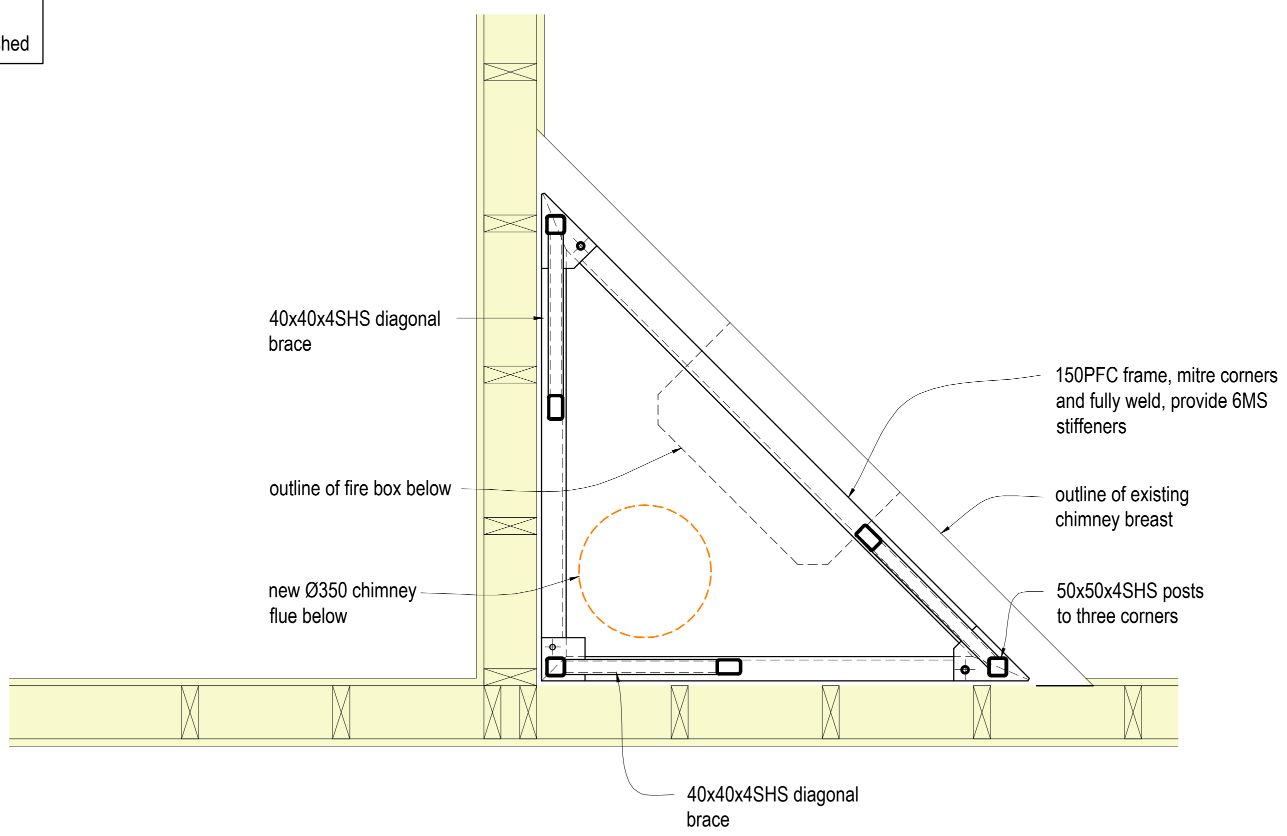

SECTION 4 -
Scale: 1:20



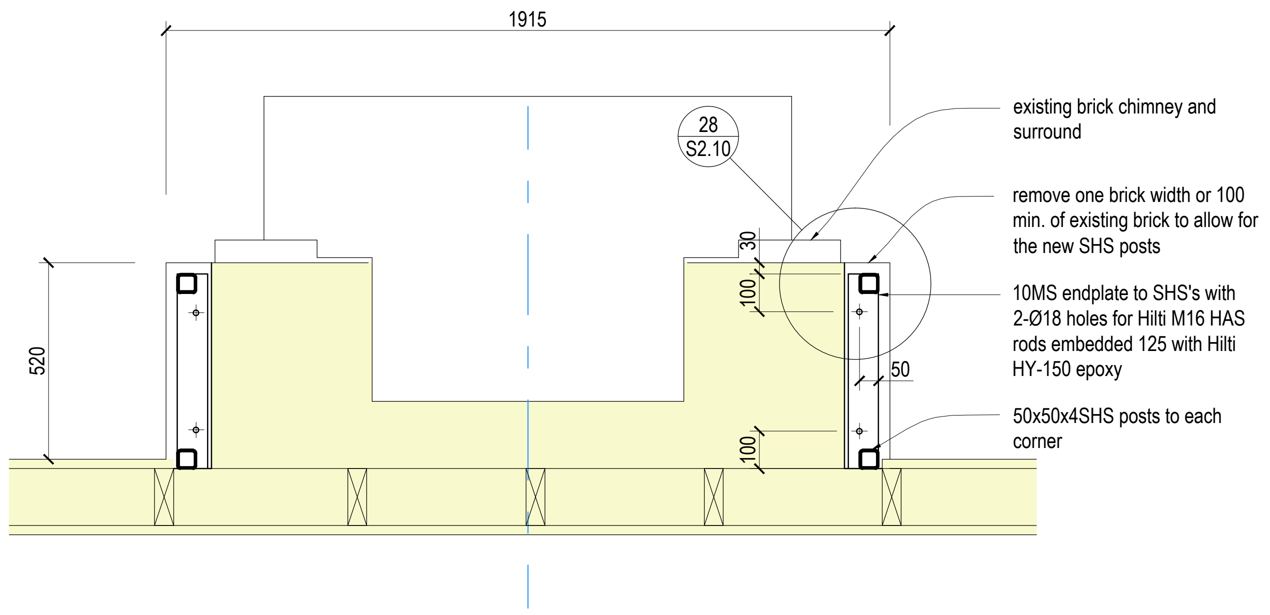

SECTION 2 -
Scale: 1:20




SECTION 5 -
Scale: 1:20

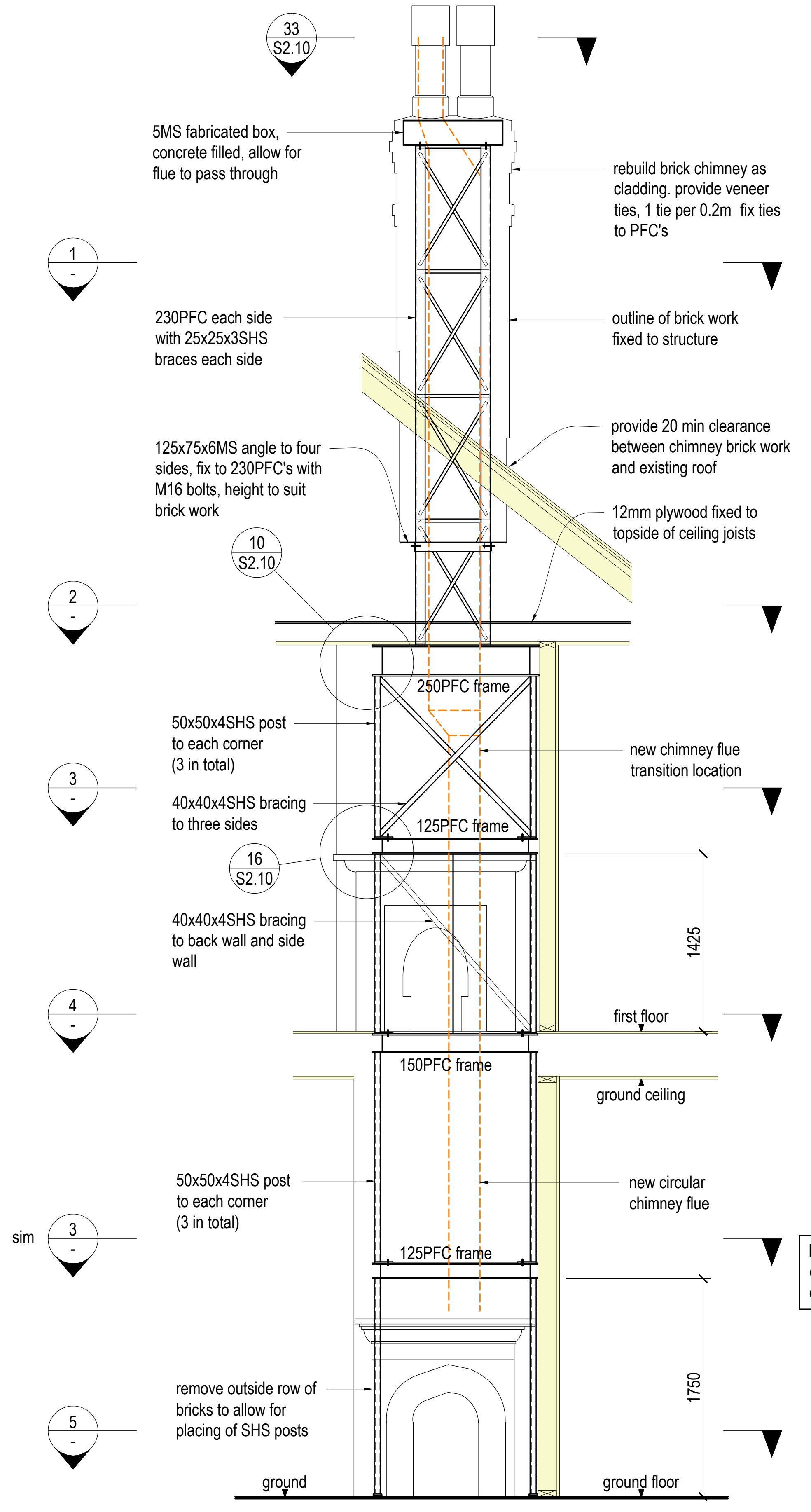



SECTION 3 -
Scale: 1:20



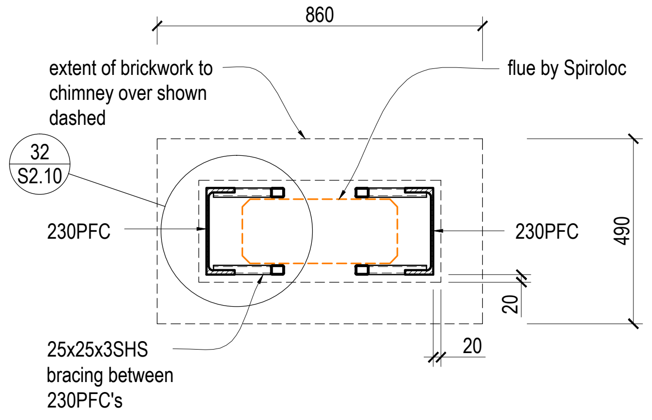

SECTION 6 -
Scale: 1:20

| issue | description | by | appd. | date | drawn | designed | approved | scales | client | project title | | drawing title | drawing no | project / issue |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | DM | EA | | 1:50<br>1:20 | INSIGHT UNLIMITED | RICCARTON HOUSE<br>16 KAHU ROAD | structex<br>"Giving support a whole new meaning" www.structex.co.nz | CHIMNEY NUMBER 3 | S2.03 | 5906<br>A |

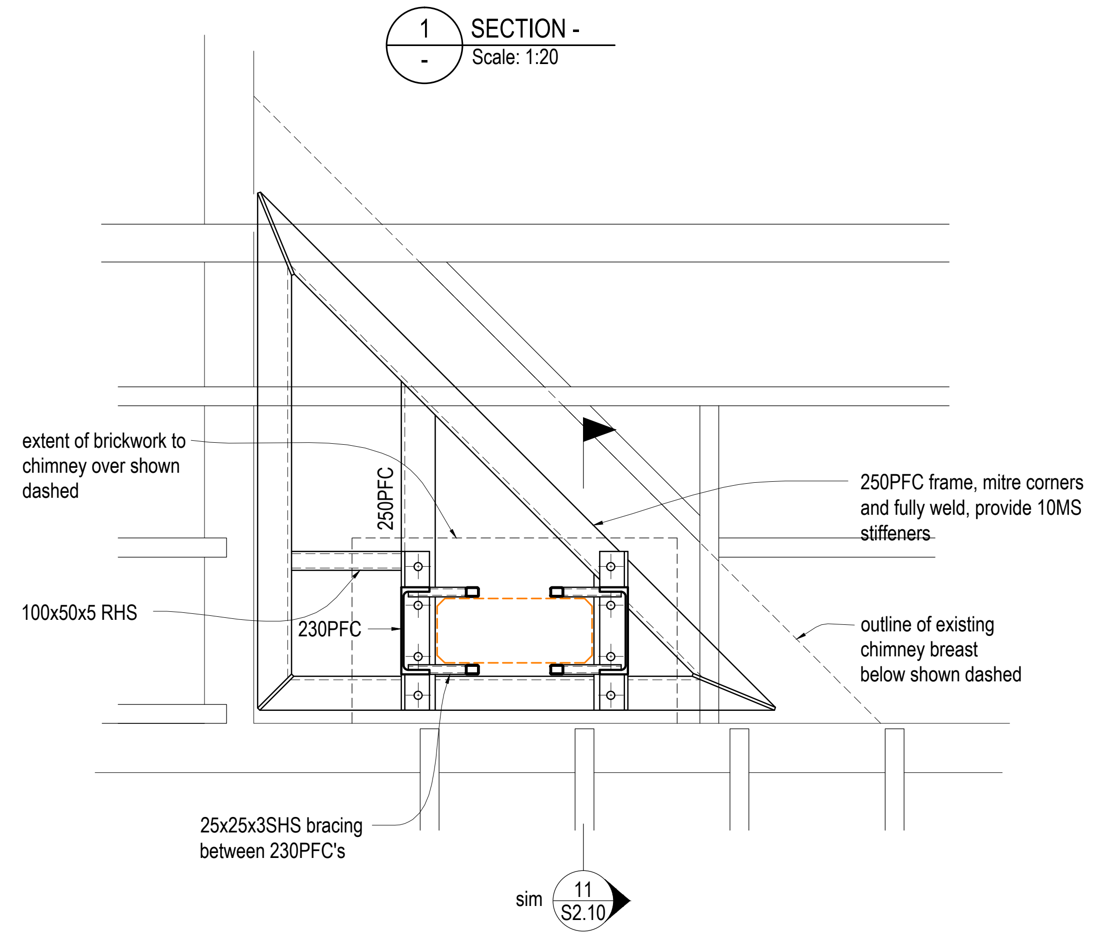



FRONT ELEVATION TO CHIMNEY 4
Scale: 1:50

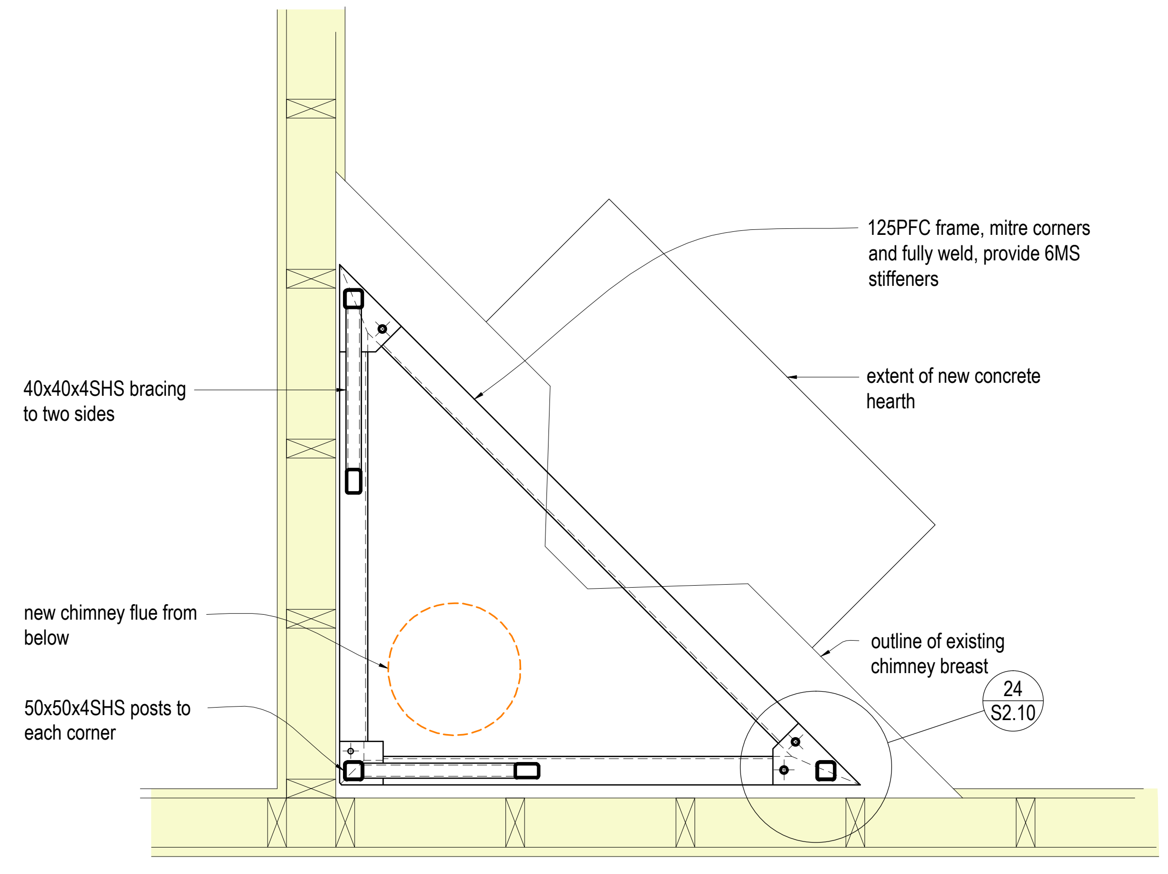
NOTE : refer to Architects drawings for extent of chimney to be demolished



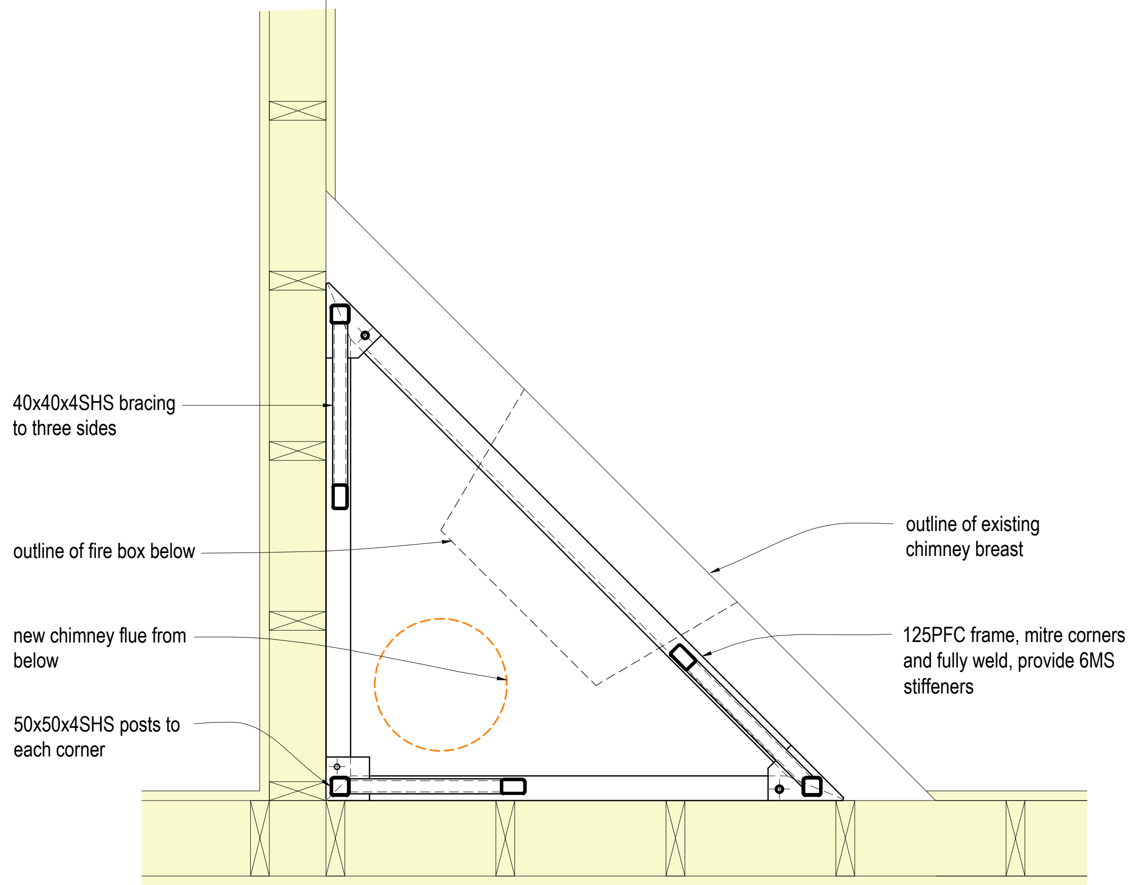

1 SECTION -
Scale: 1:20



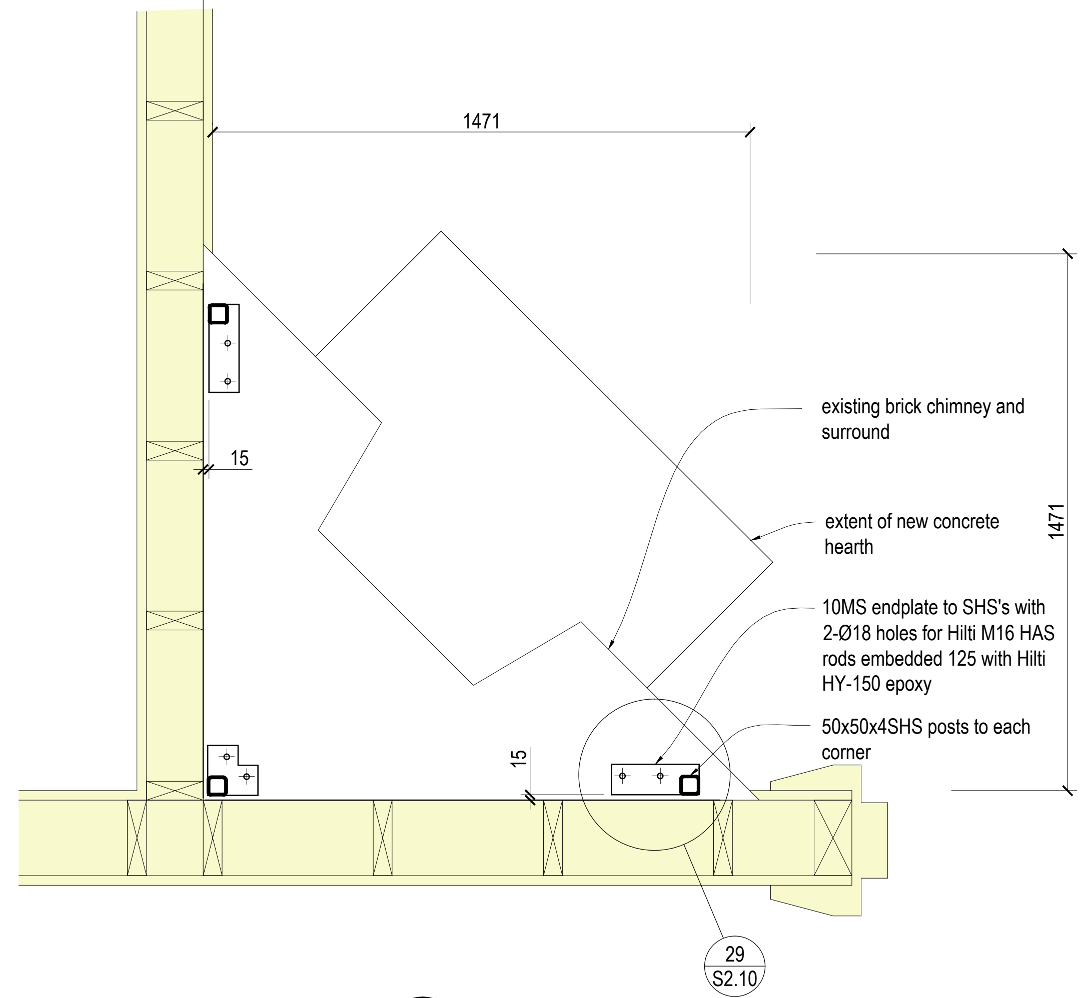

2 SECTION -
Scale: 1:20




4 SECTION -
Scale: 1:20




3 SECTION -
Scale: 1:20




5 SECTION -
Scale: 1:20

GENERAL NOTES:

1. Detailed plans are orientated with north looking up the page and therefore may not necessarily correspond with the Front Elevation
2. All dimensions shown are to be confirmed on site and with the Architects drawings

| issue | description | by | appd. | date | drawn | designed | approved | scales | client | project title | drawing title | drawing no | project / issue |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | DM | EA | | 1:50<br>1:20 | INSIGHT UNLIMITED | RICCARTON HOUSE<br>16 KAHU ROAD | CHIMNEY NUMBER 4 | S2.04 | 5906<br>A |

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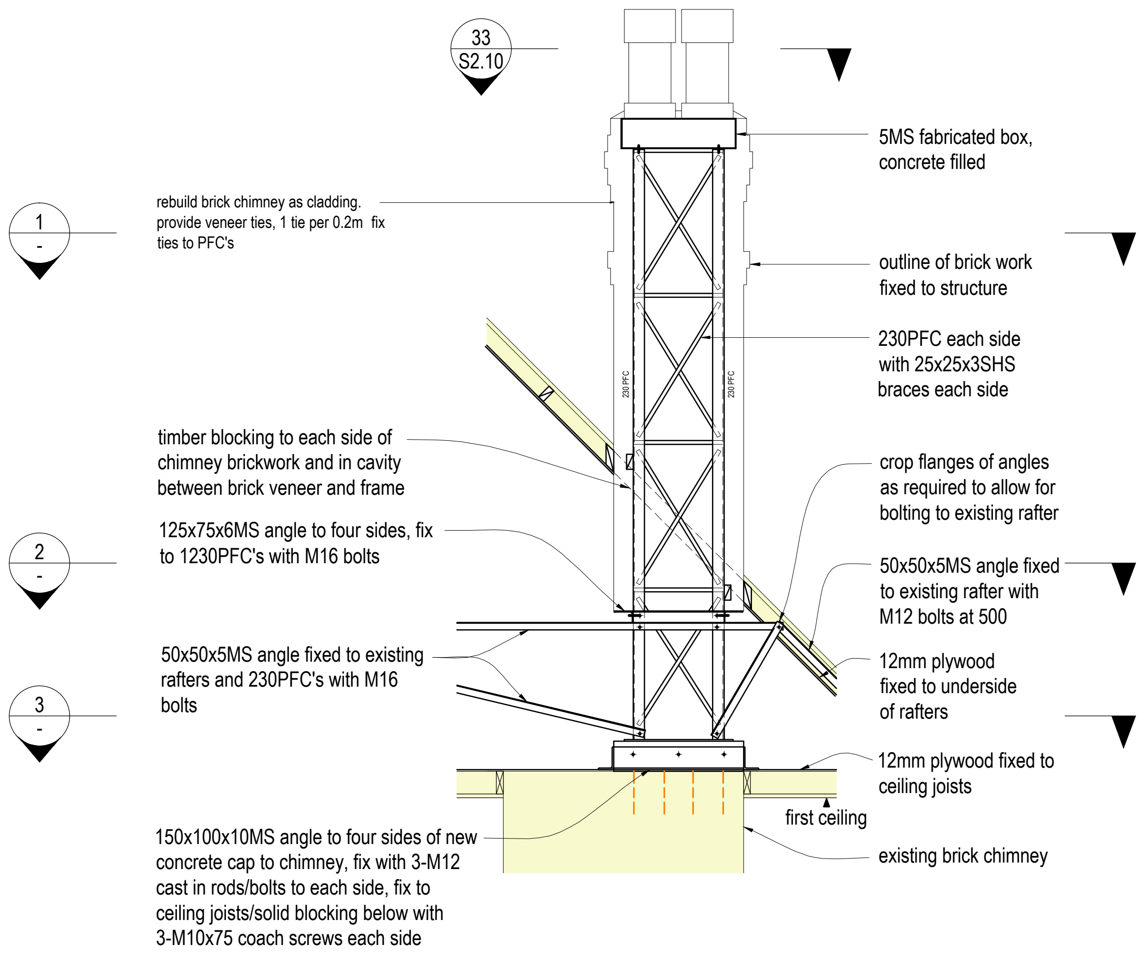
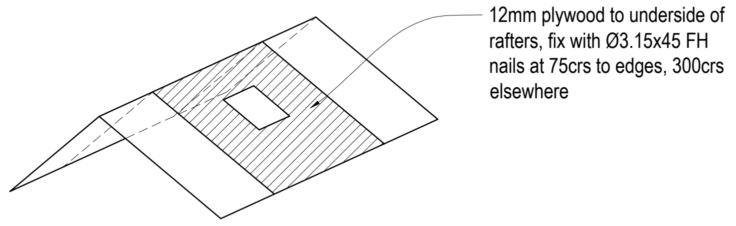
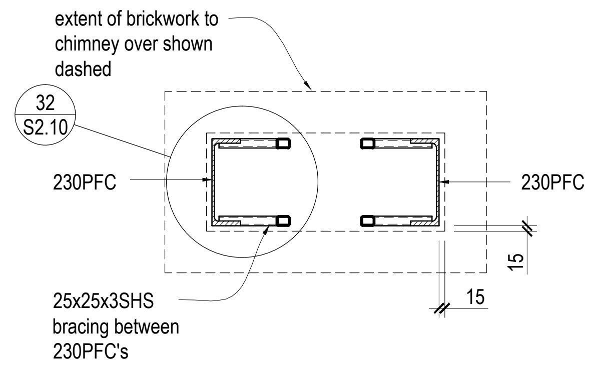


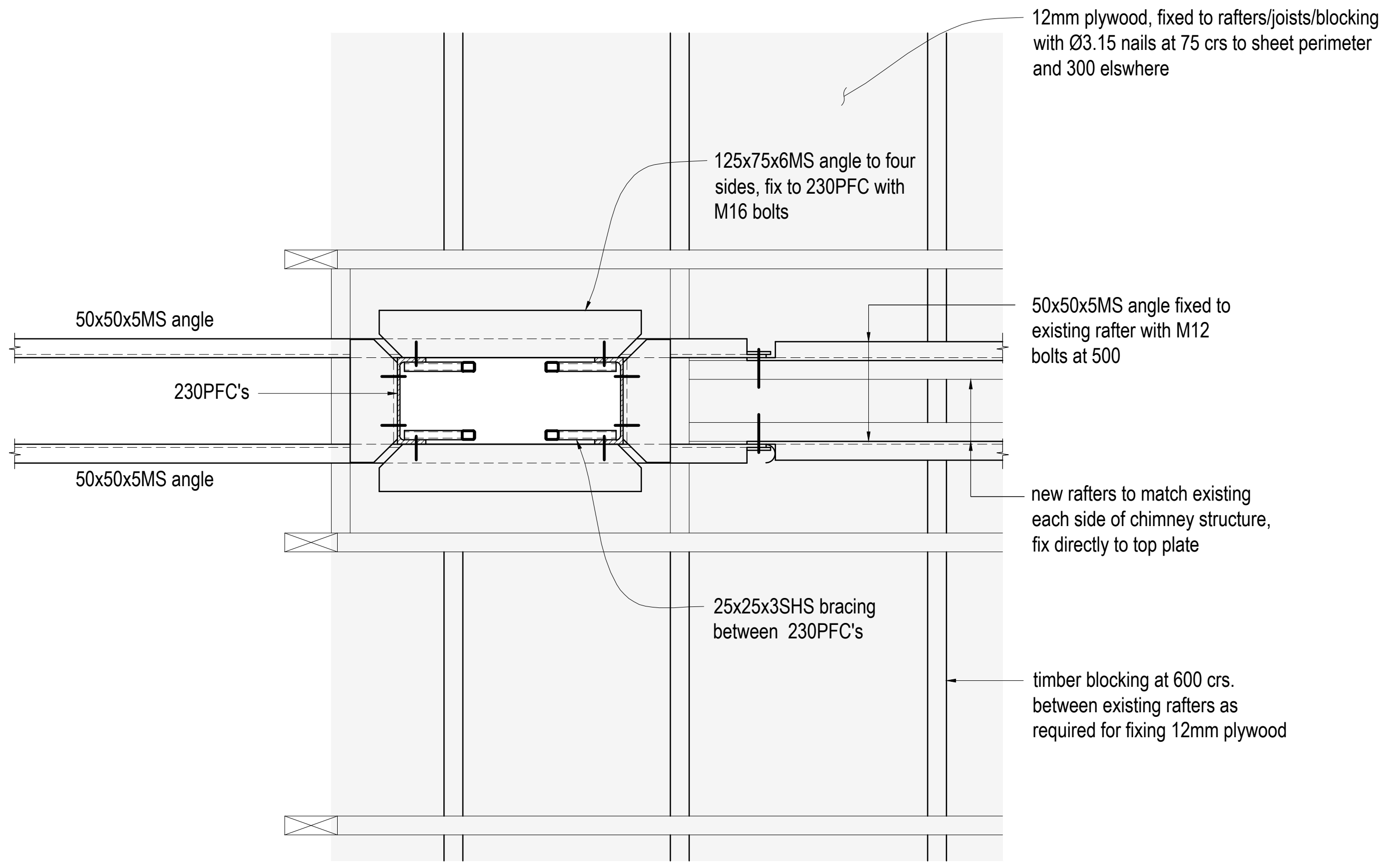

FRONT ELEVATION TO CHIMNEY 5
Scale: 1:50



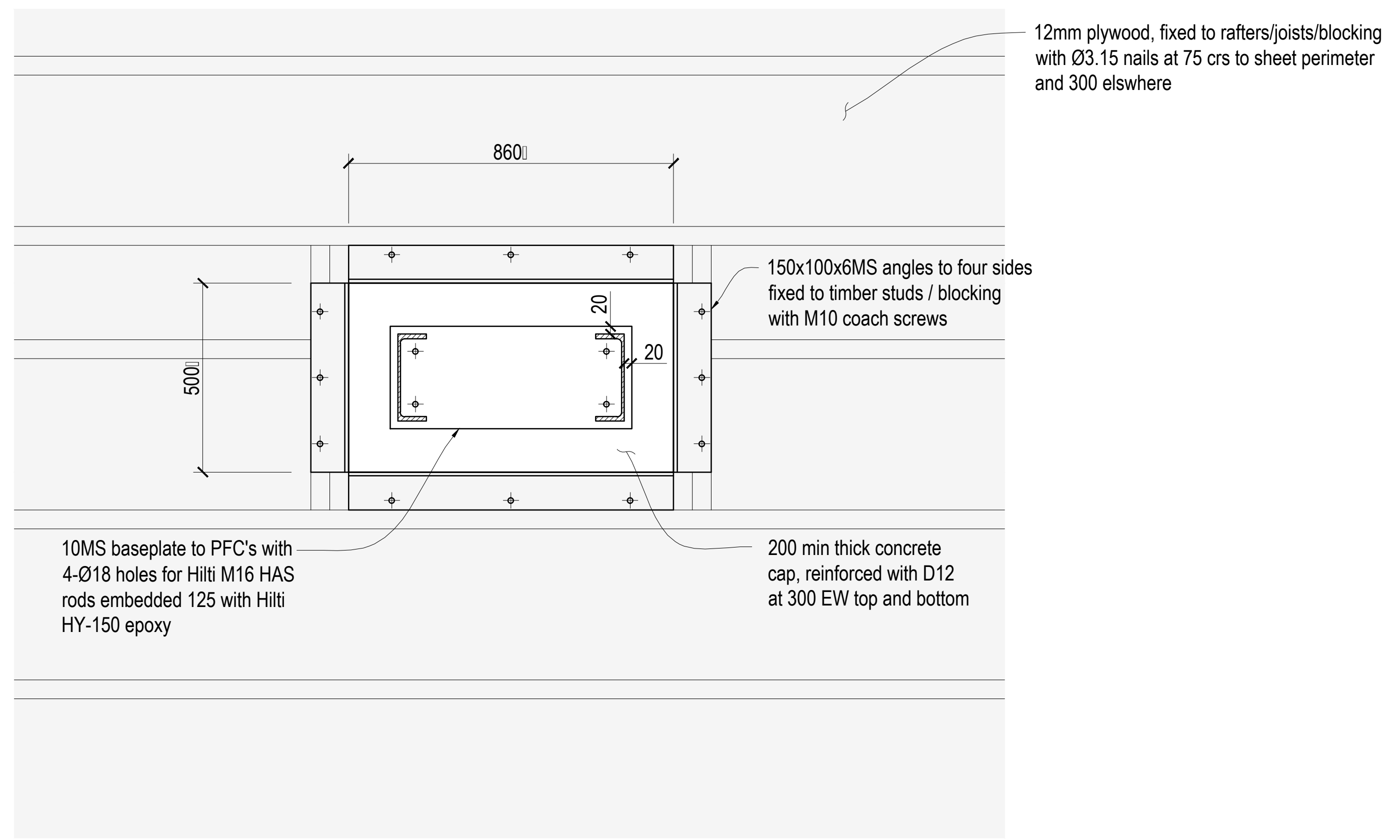

extent of plwood linings to rafters




1 SECTION -
Scale: 1:20




2 SECTION -
Scale: 1:20



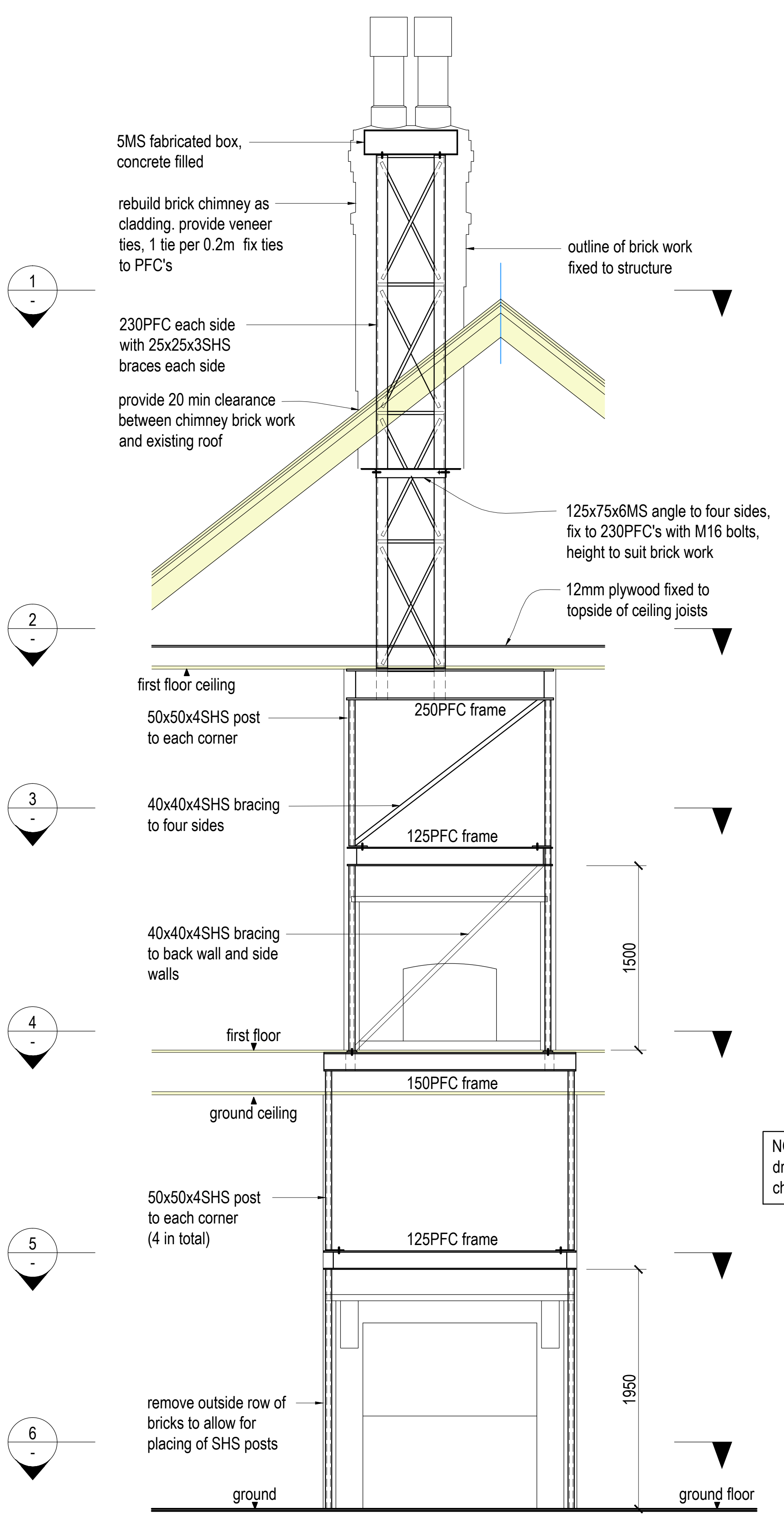

3 SECTION -
Scale: 1:20

GENERAL NOTES

1. Detailed plans are orientated with north looking up the page and therefore may not necessary correspond with the Front Elevation
2. All dimensions shown are to be confirmed on site and with the Architects drawings

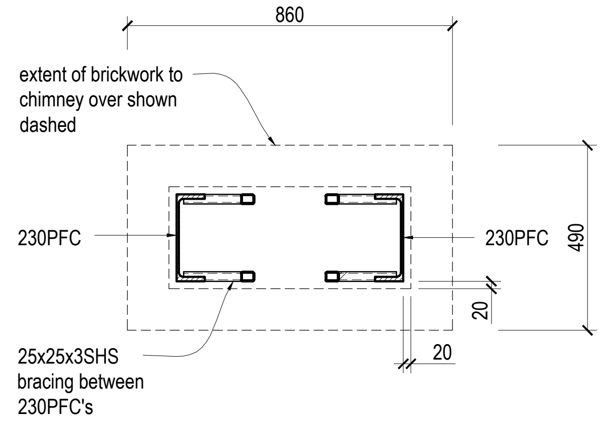
| issue | description | by | appd. | date | drawn | designed | approved | scales | client | project title | | drawing title | drawing no | project / issue |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | DM | EA | | 1:50<br>1:20 | INSIGHT UNLIMITED | RICCARTON HOUSE<br>16 KAHU ROAD | structex<br>"Giving support a whole new meaning" www.structex.co.nz | CHIMNEY NUMBER 5 | S2.05 | 5906<br>A |

P:\PROJECTS\5906\D\CHIMNEYS.DWG 10/10/11 12:08 A2 ORIGINAL

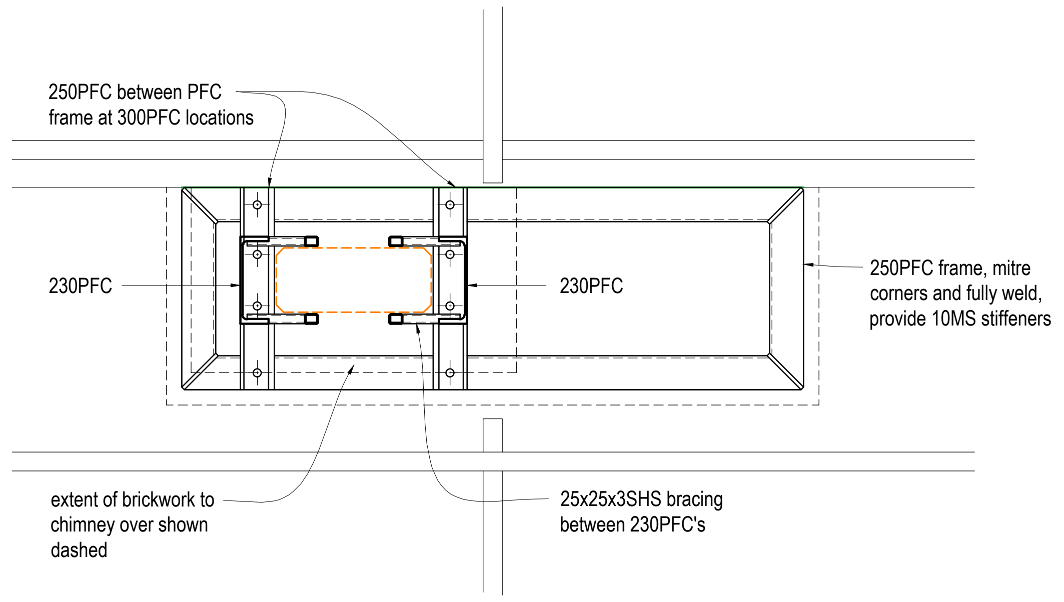



FRONT ELEVATION TO CHIMNEY 6
Scale: 1:50

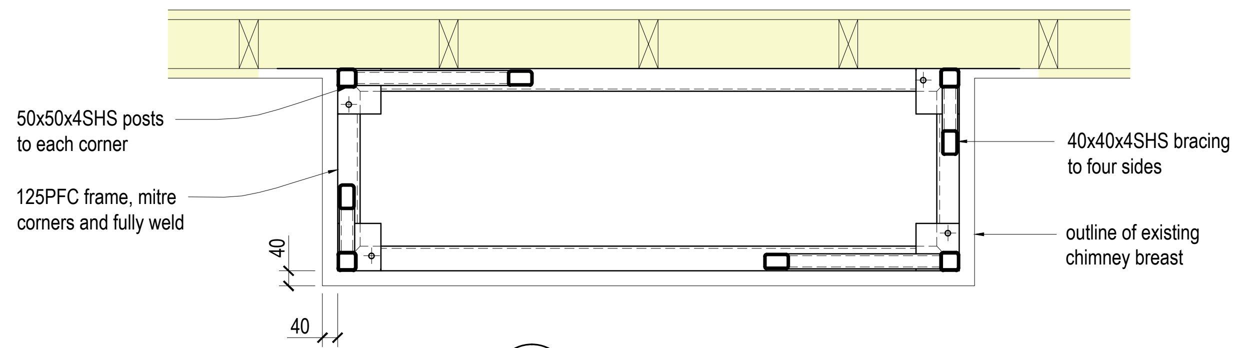
NOTE : refer to Architects drawings for extent of chimney to be demolished



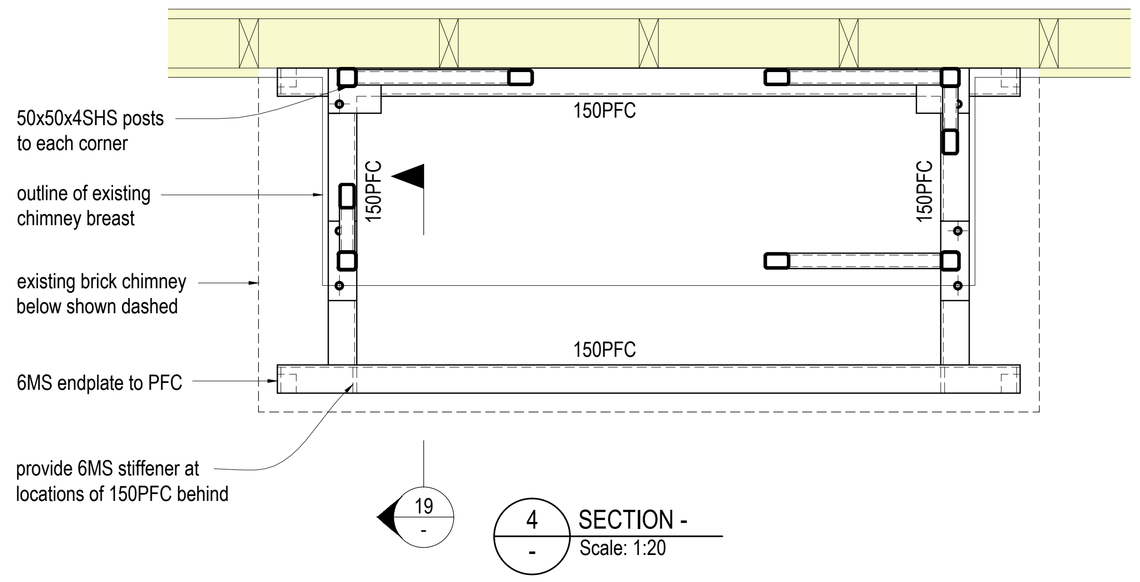

SECTION 1
Scale: 1:20



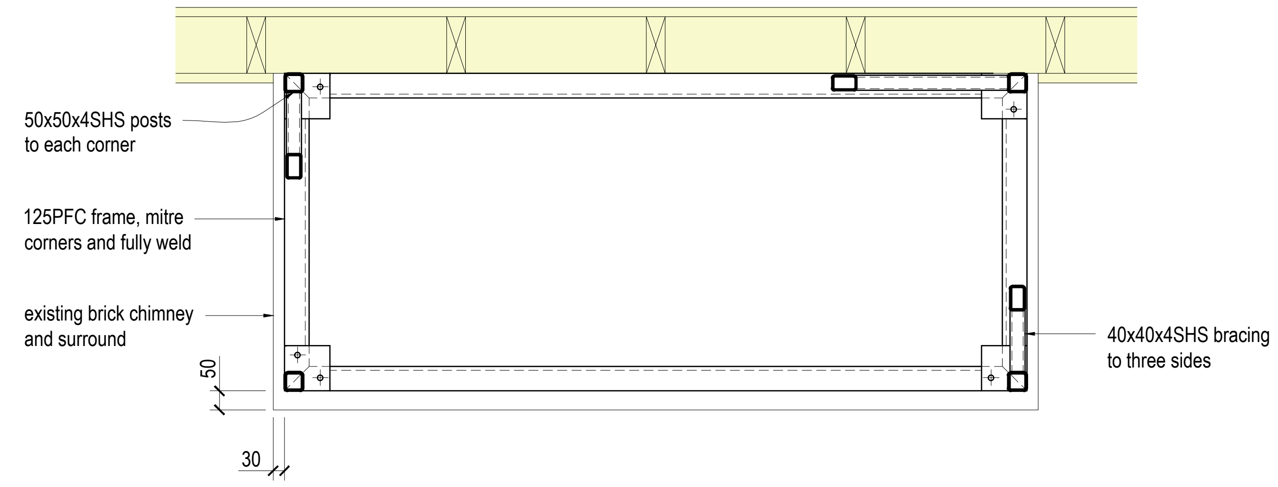

SECTION 2
Scale: 1:20



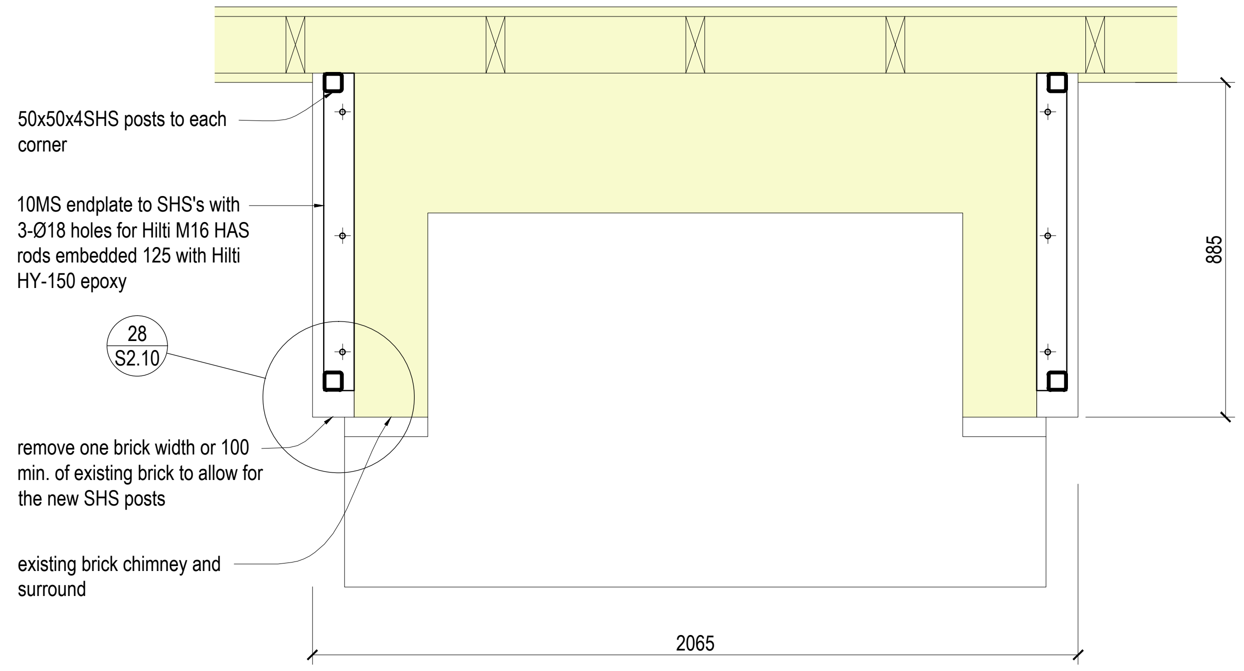

SECTION 3
Scale: 1:20




SECTION 4
Scale: 1:20




SECTION 5
Scale: 1:20

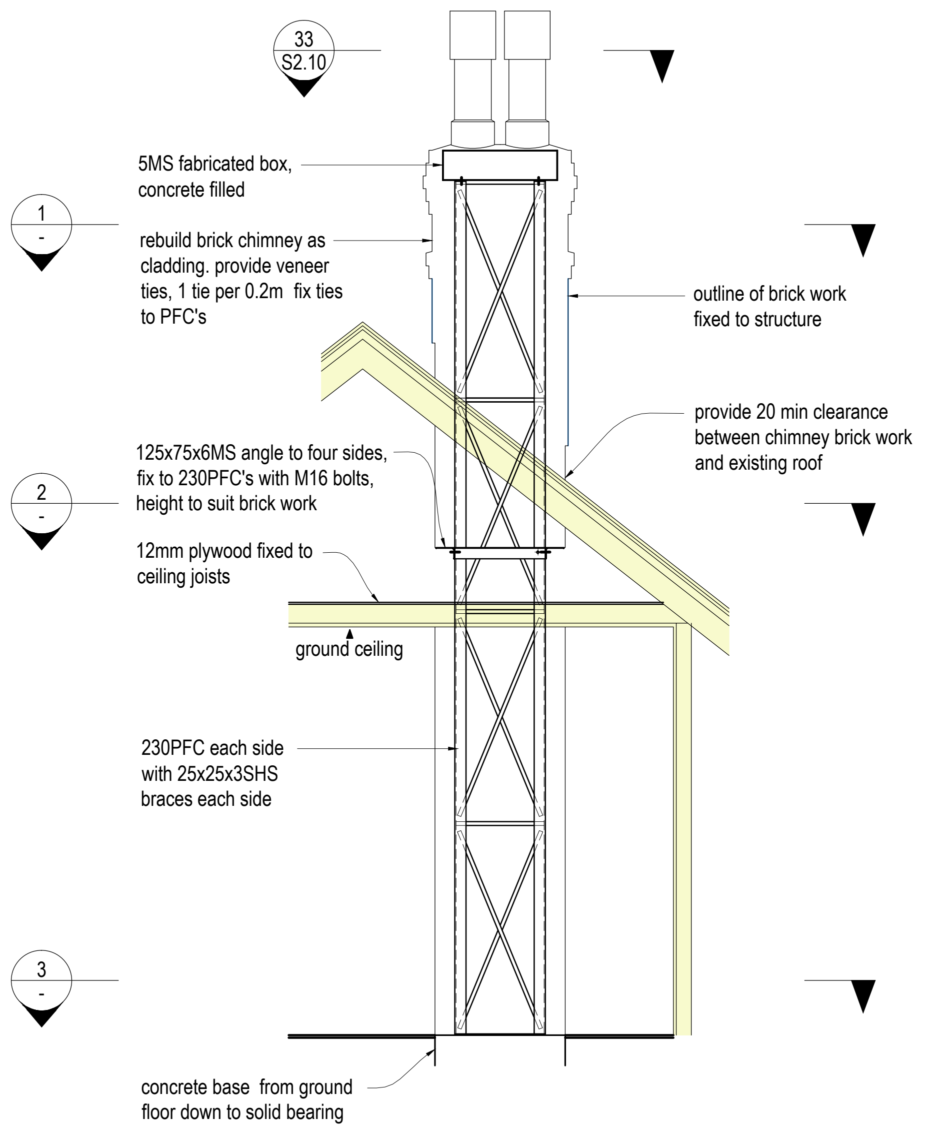



SECTION 6
Scale: 1:20

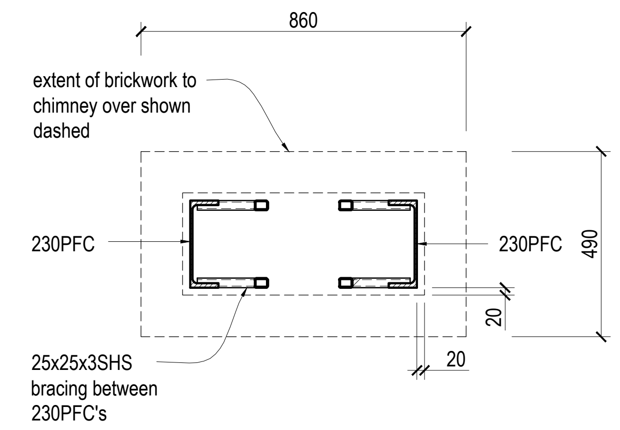
GENERAL NOTES:

1. Detailed plans are orientated with north looking up the page and therefore may not necessary correspond with the Front Elevation
2. All dimensions shown are to be confirmed on site and with the Architects drawings

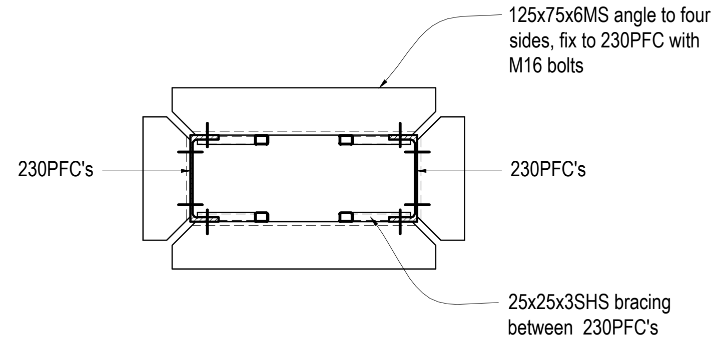
| issue | description | by | appd. | date | drawn | designed | approved | scales | client | project title | | drawing title | drawing no | project / issue |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | DM | EA | | 1:50<br>1:20 | INSIGHT UNLIMITED | RICCARTON HOUSE<br>16 KAHU ROAD | structex<br>"Giving support a whole new meaning" www.structex.co.nz | CHIMNEY NUMBER 6 | S2.06 | 5906<br>A |



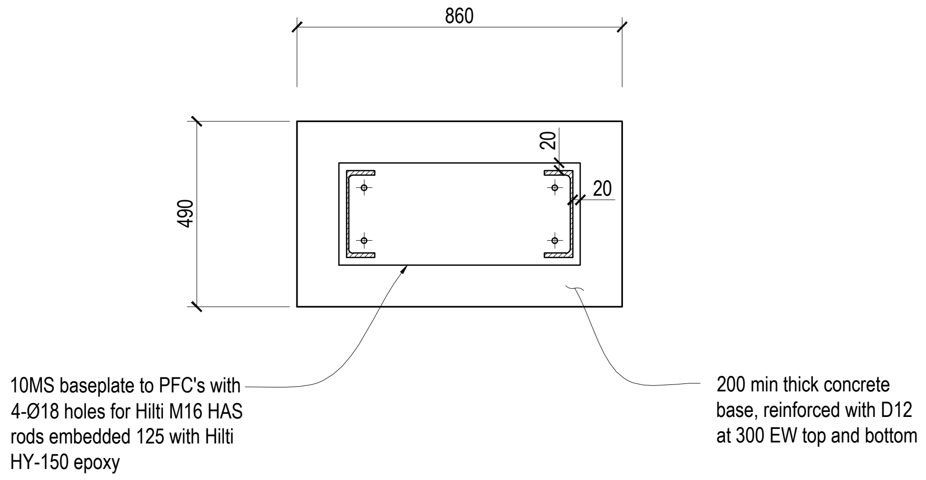

FRONT ELEVATION TO CHIMNEY 7
Scale: 1:50




1 SECTION -
Scale: 1:20




2 SECTION -
Scale: 1:20

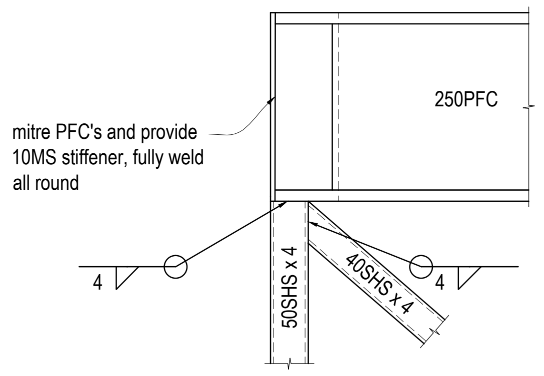



3 SECTION -
Scale: 1:20

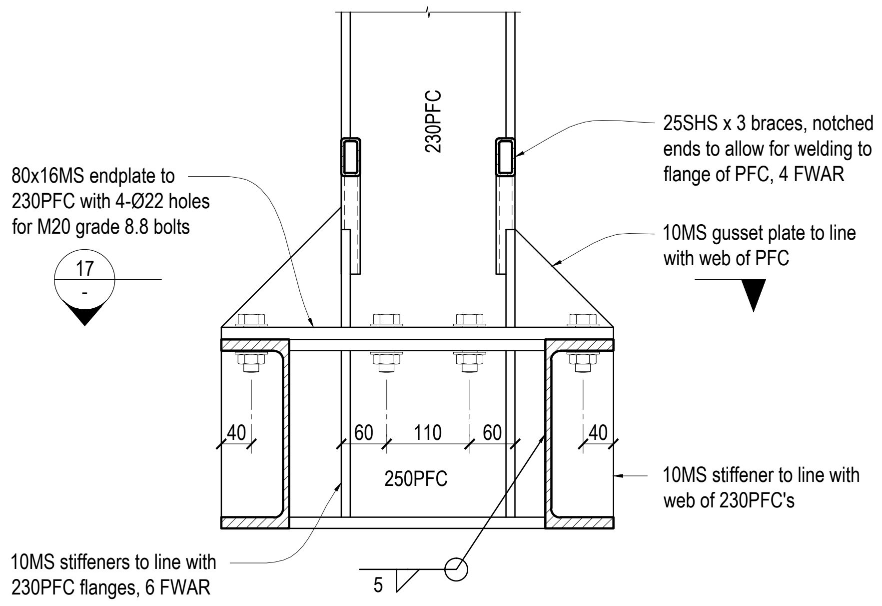
GENERAL NOTES:

1. Detailed plans are orientated with north looking up the page and therefore may not necessary correspond with the Front Elevation
2. All dimensions shown are to be confirmed on site and with the Architects drawings

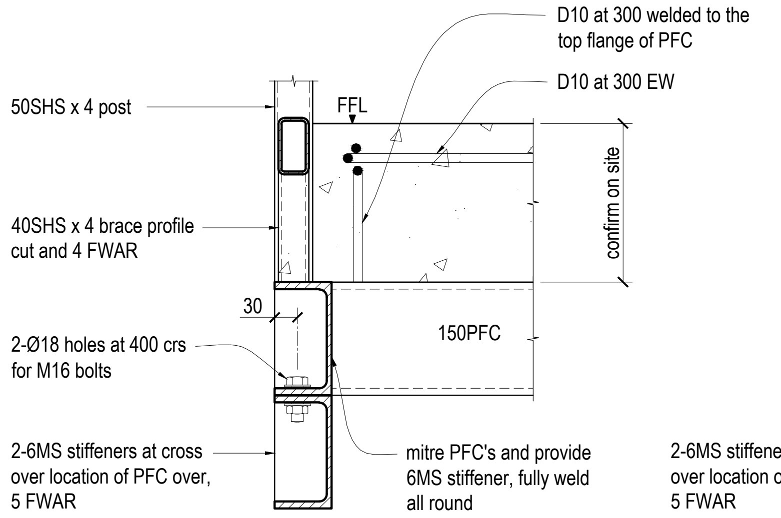
| issue | description | by | appd. | date | drawn | designed | approved | scales | client | project title | | drawing title | drawing no | project / issue |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | DM | EA | | 1:50<br>1:20 | INSIGHT UNLIMITED | RICCARTON HOUSE<br>16 KAHU ROAD | structex<br>"Giving support a whole new meaning" www.structex.co.nz | CHIMNEY NUMBER 7 | S2.07 | 5906<br>A |



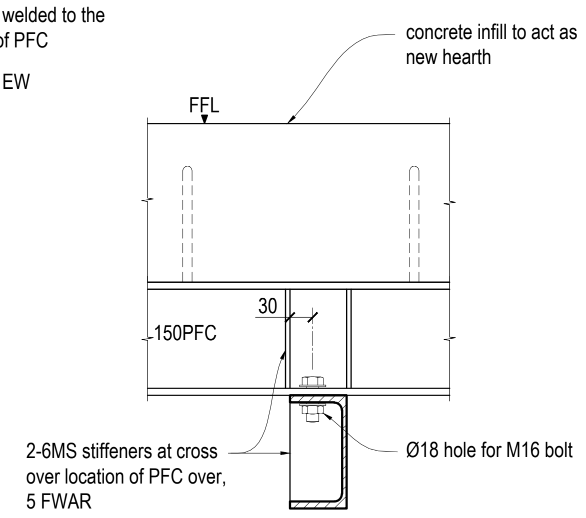

10 SECTION - Scale: 1:10



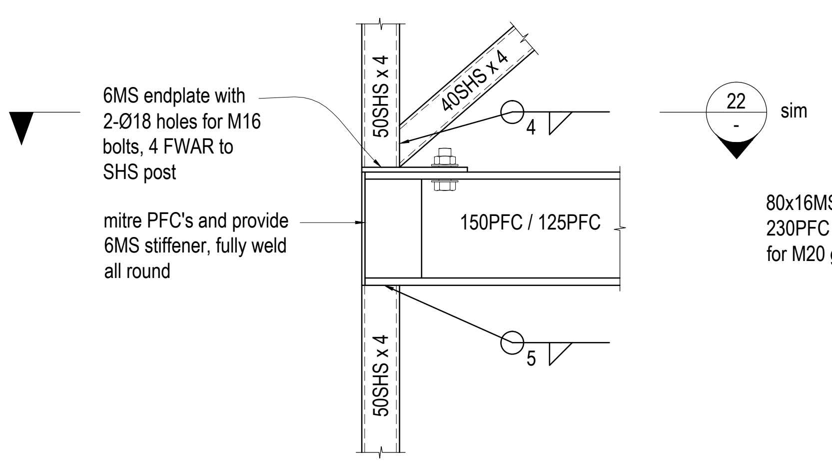

11 SECTION - Scale: 1:10



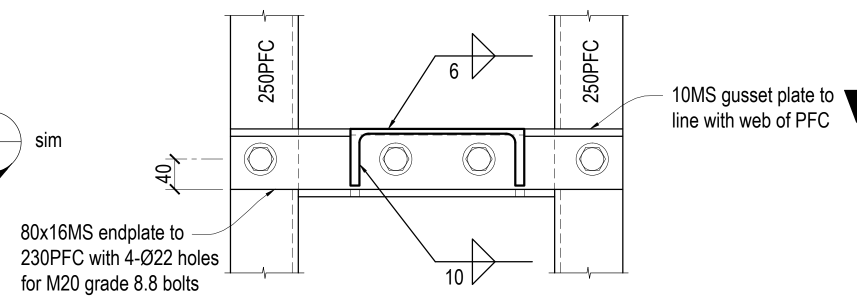

12 SECTION - Scale: 1:10



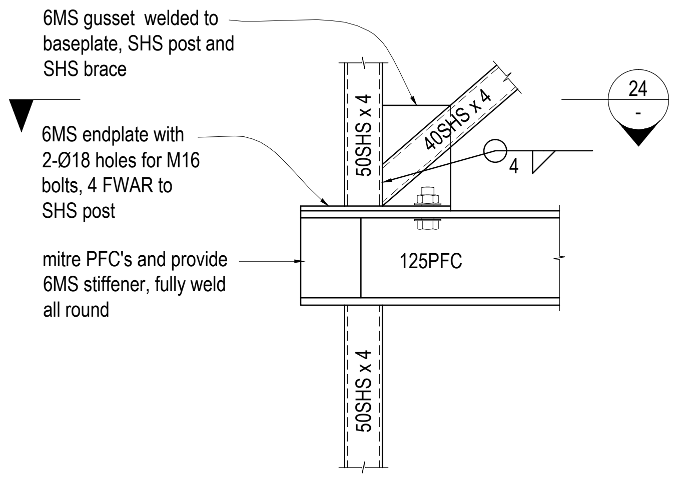

13 SECTION - Scale: 1:10



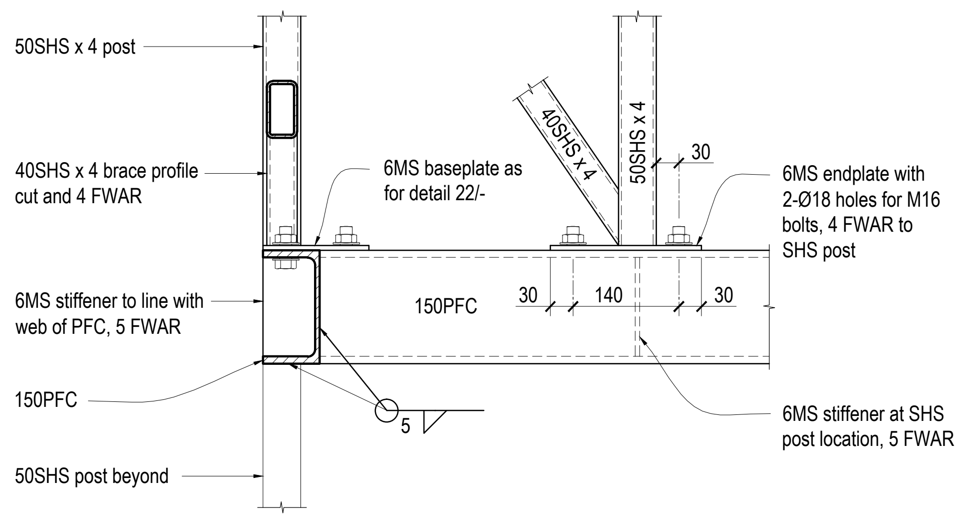

16 SECTION - Scale: 1:10



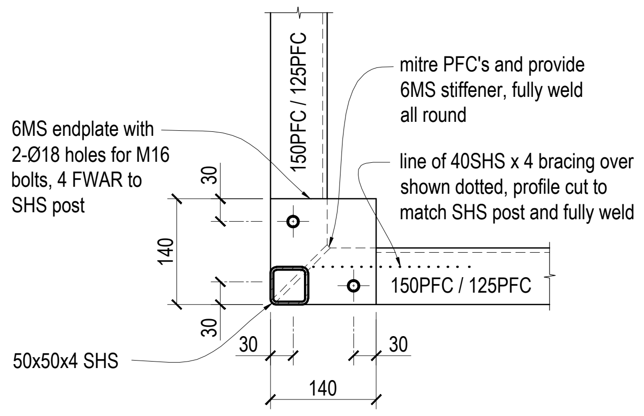

17 SECTION - Scale: 1:10



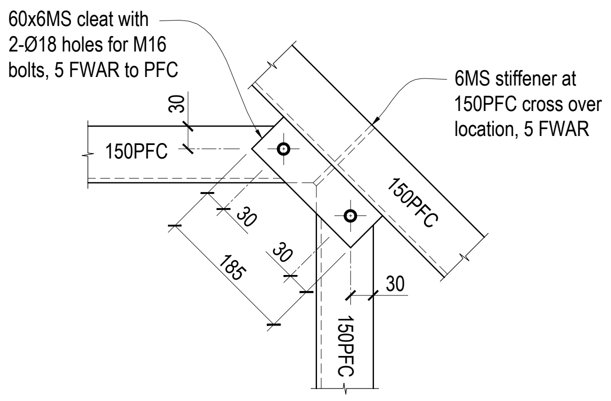

18 SECTION - Scale: 1:10



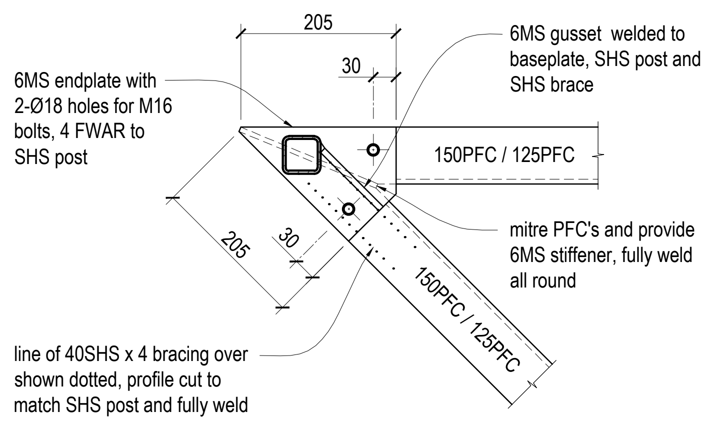

19 SECTION - Scale: 1:10



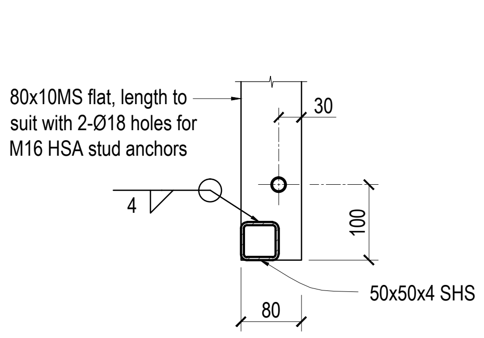

22 SECTION - Scale: 1:10



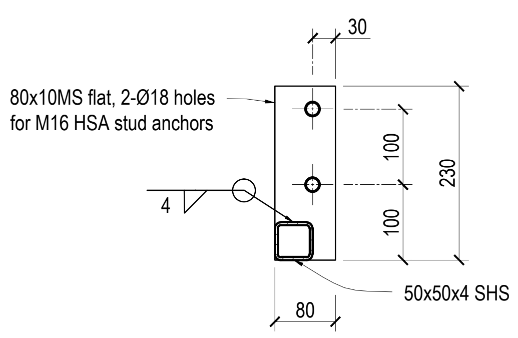

23 SECTION - Scale: 1:10



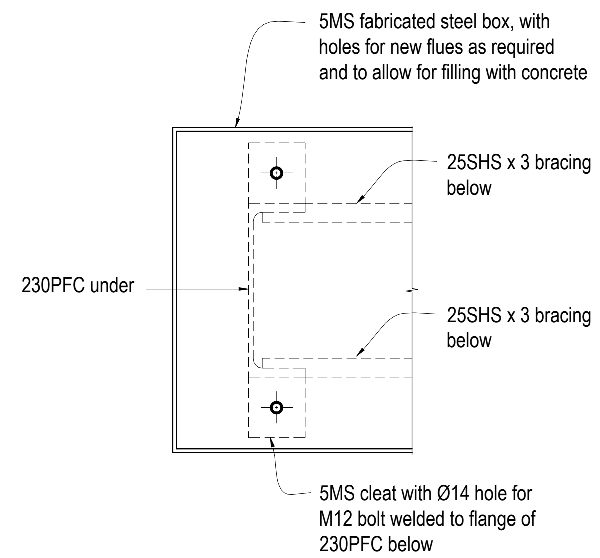

24 SECTION - Scale: 1:10




28 SECTION - Scale: 1:10



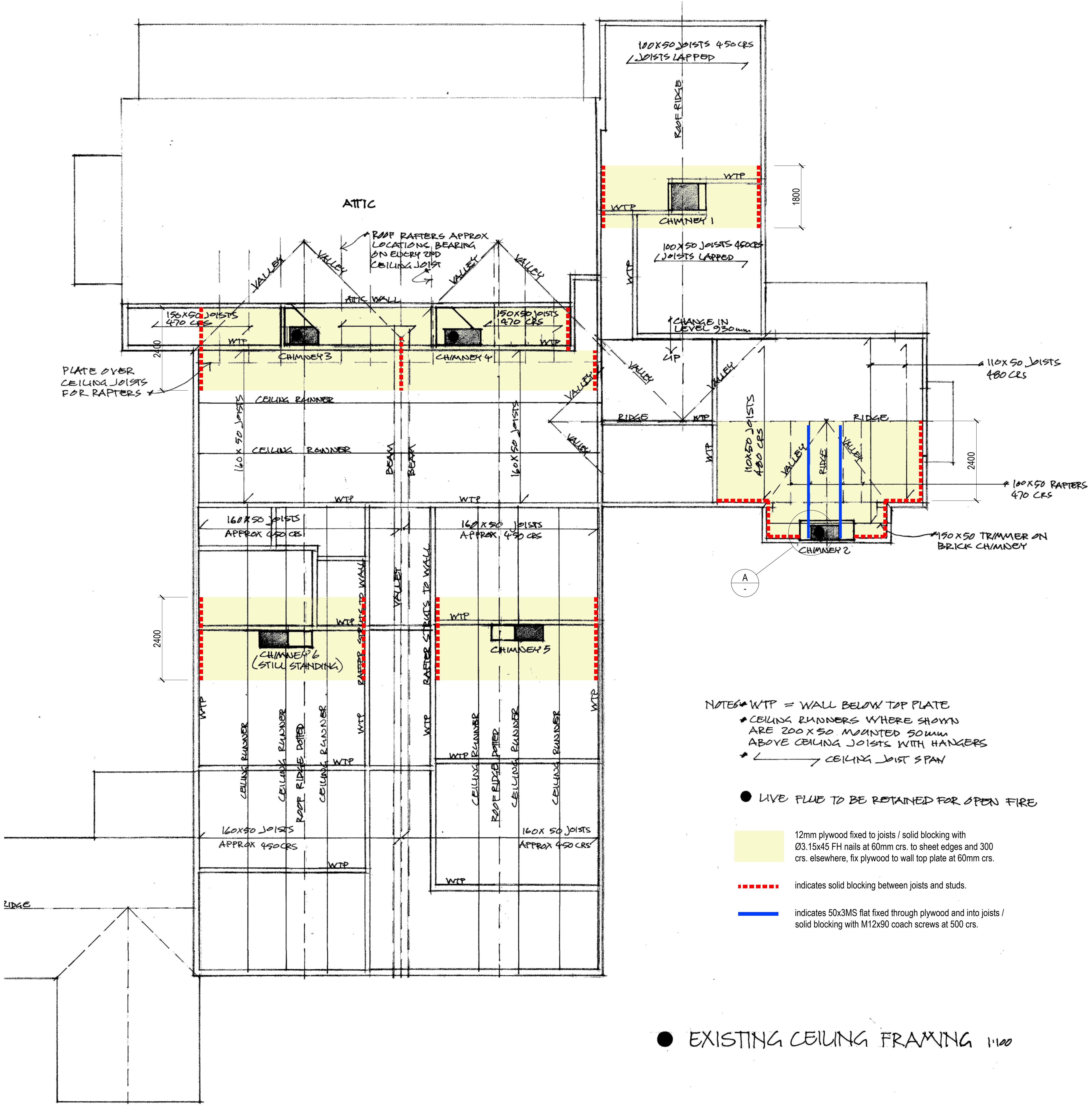

29 SECTION - Scale: 1:10



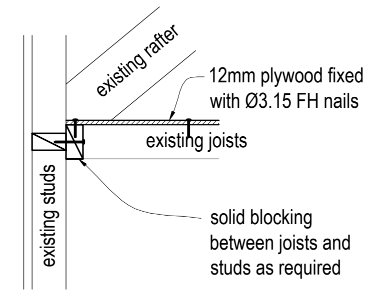

33 SECTION - Scale: 1:10

| issue | description | by | appd. | date | drawn | designed | approved | scales | client | project title | | drawing title | drawing no | project / issue |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | DM | EA | | 1:10 | INSIGHT UNLIMITED | RICCARTON HOUSE 16 KAHU ROAD | structex "Giving support a whole new meaning" www.structex.co.nz | CHIMNEY DETAILS | S2.10 | 5906 / A |

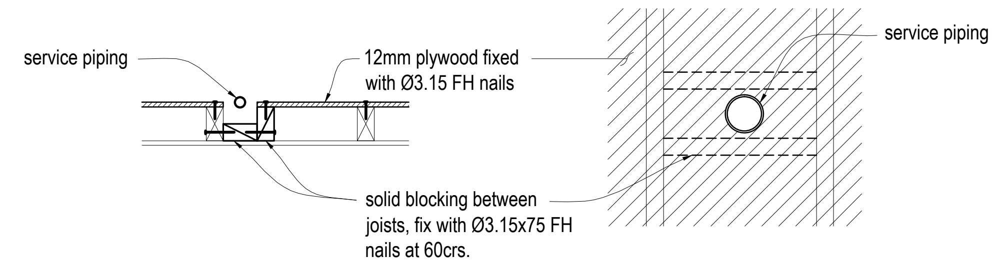
P:\PROJECTS\5906\D\CHIMNEYS.DWG 10/10/11 12:09 A2 ORIGINAL




EXISTING CEILING FRAMING 1:100



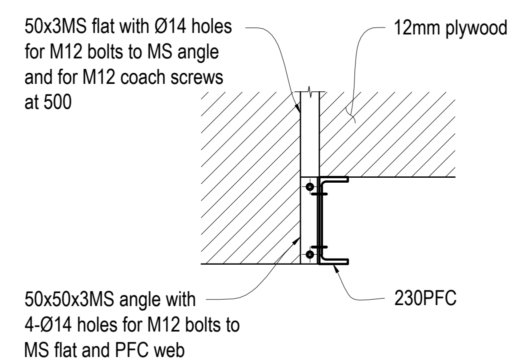

BLOCKING DETAIL TO PLYWOOD EDGE
Scale: 1:20




HORIZONTAL SERVICES
alternatively services can be moved

VERTICAL SERVICES

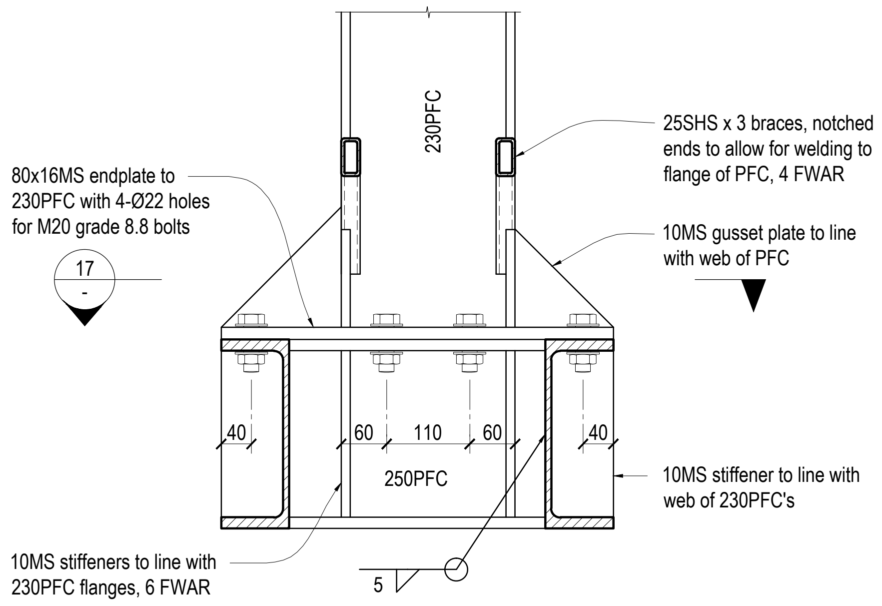
STANDARD DETAILS AROUND SERVICES
Scale: 1:20



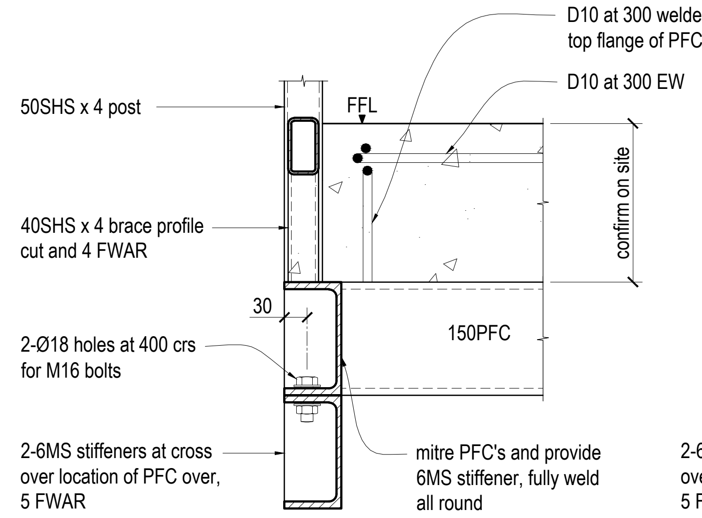

A DETAIL -
Scale: 1:20

| issue | description | by | appd. | date | drawn | designed | approved | scales | client | project title | | drawing title | drawing no | project / issue |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | DM | EA | | 1:100 1:20 | INSIGHT UNLIMITED | RICCARTON HOUSE 16 KAHU ROAD | structex "Giving support a whole new meaning" www.structex.co.nz | CEILING BRACING | S2.15 | 5906 / A |

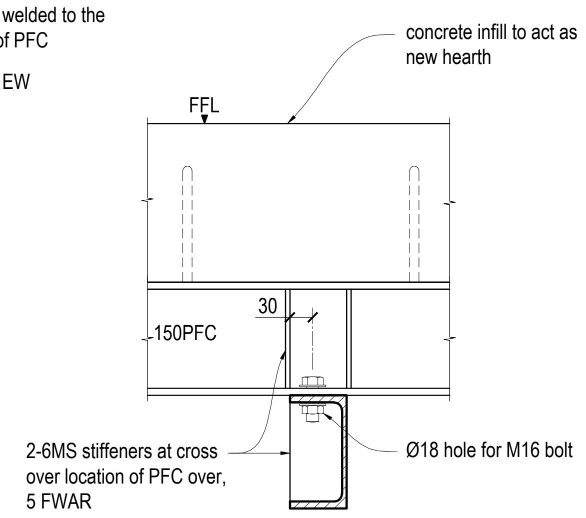
 



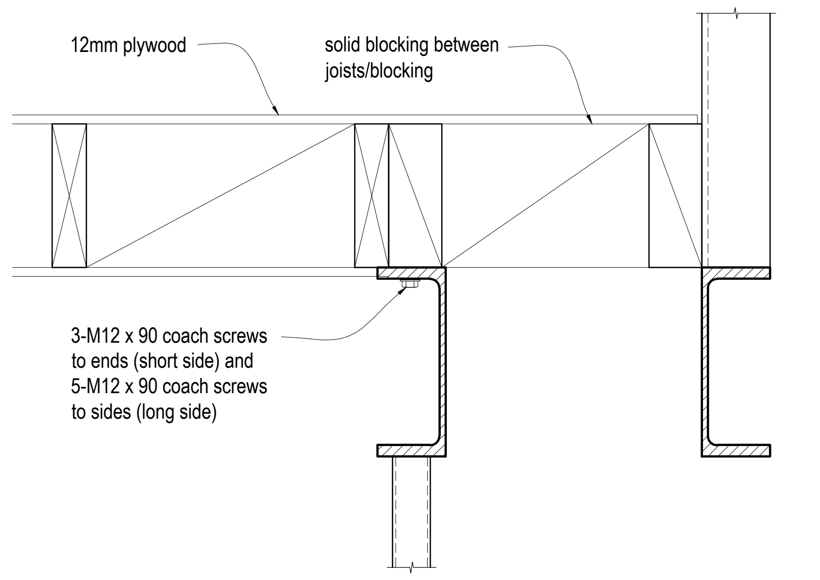

11 SECTION - Scale: 1:10



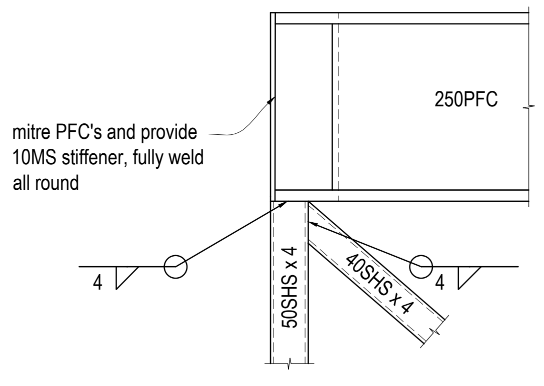

12 SECTION - Scale: 1:10



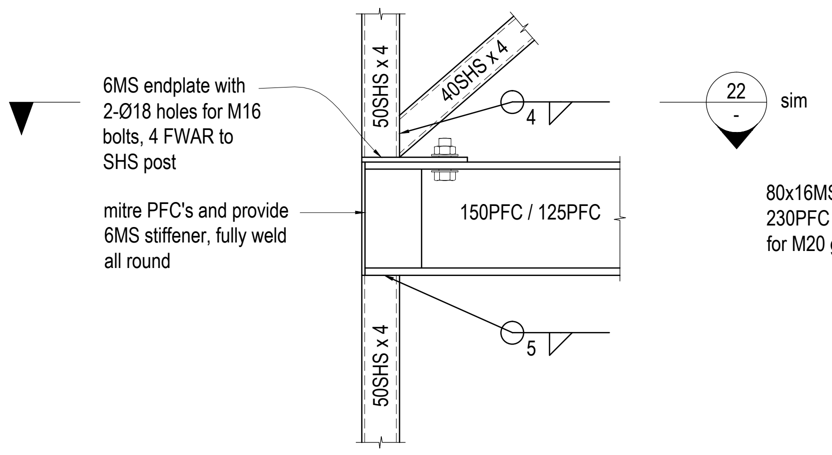

13 SECTION - Scale: 1:10



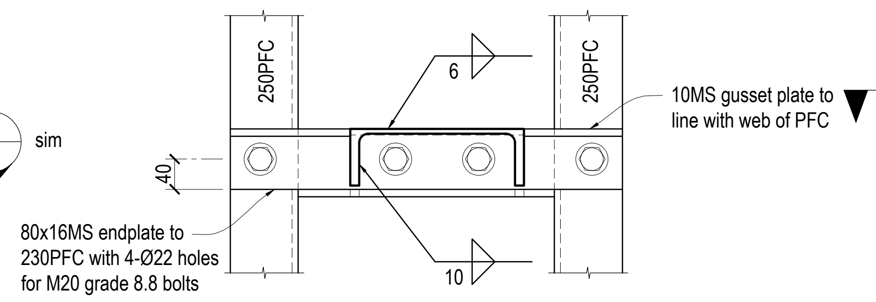

TYPICAL PLYWOOD CEILING CONNECTION
Scale: 1:10



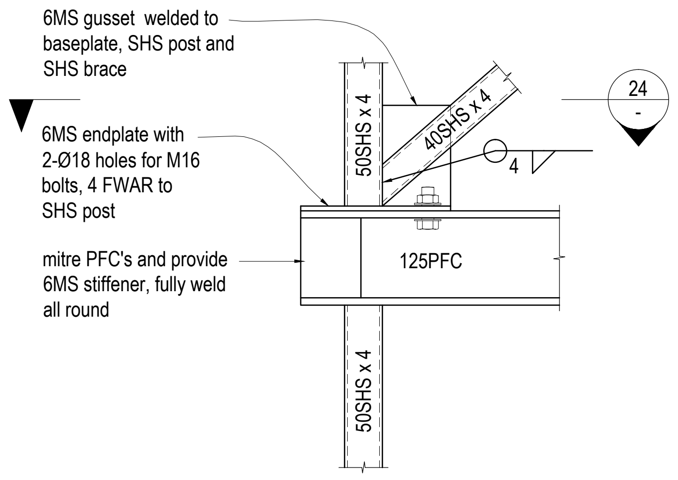

10 SECTION - Scale: 1:10



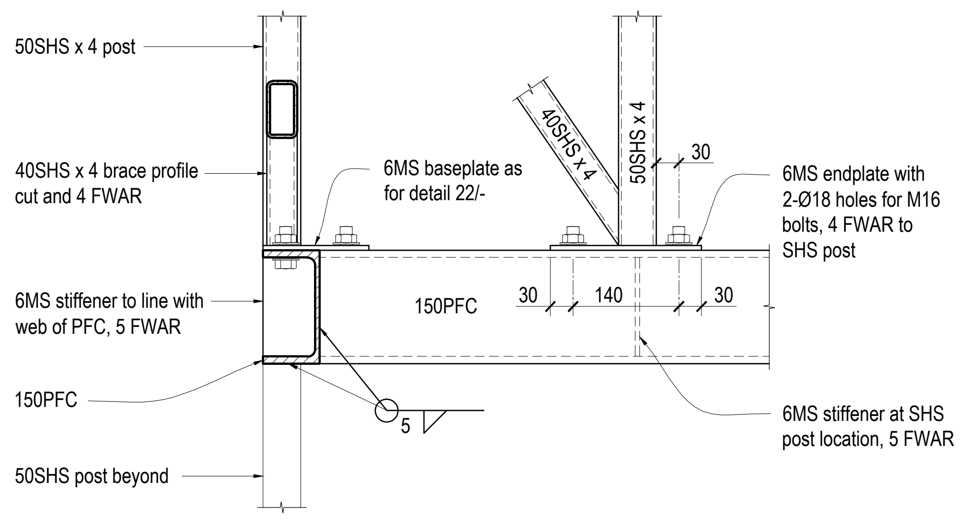

16 SECTION - Scale: 1:10



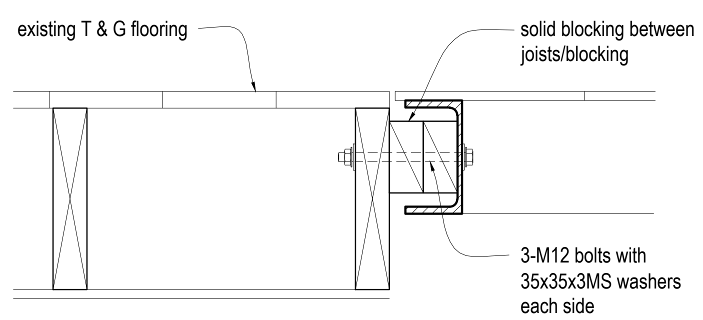

17 SECTION - Scale: 1:10



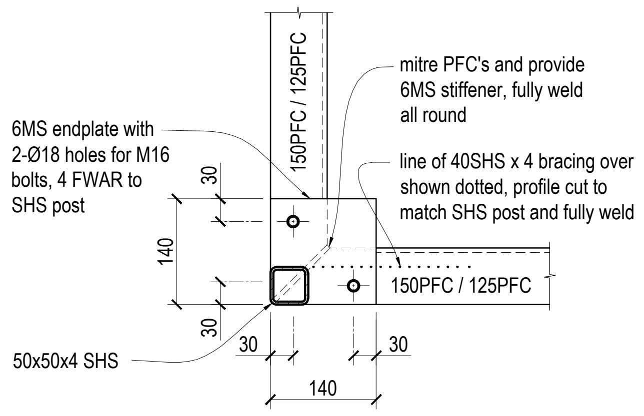

18 SECTION - Scale: 1:10



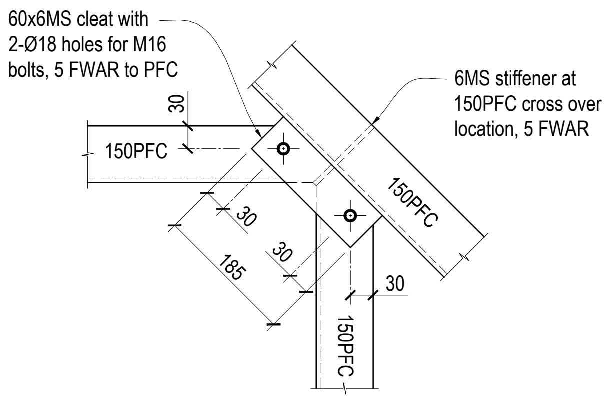

19 SECTION - Scale: 1:10



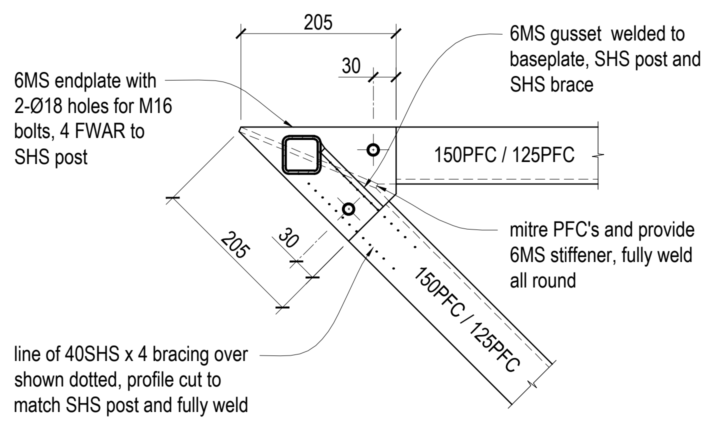

TYPICAL FIRST FLOOR CONNECTION
Scale: 1:10



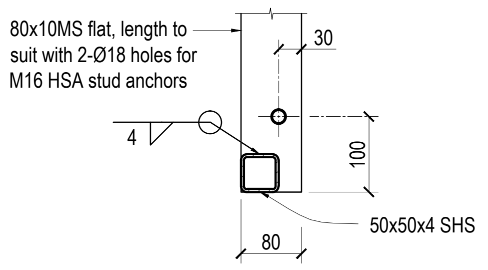

22 SECTION - Scale: 1:10



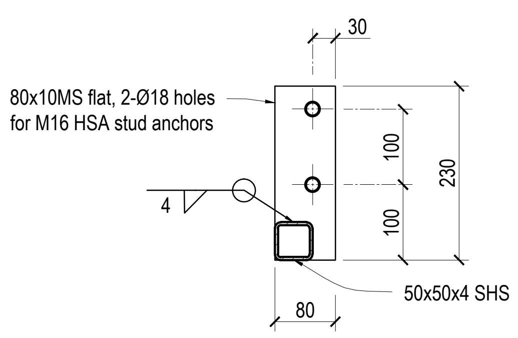

23 SECTION - Scale: 1:10



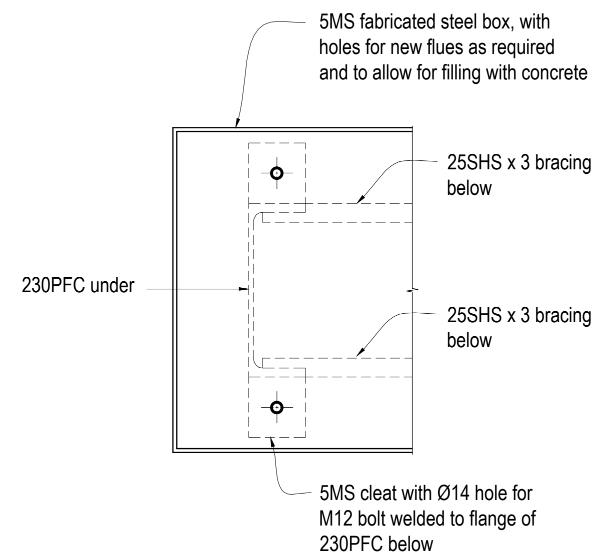

24 SECTION - Scale: 1:10




28 SECTION - Scale: 1:10



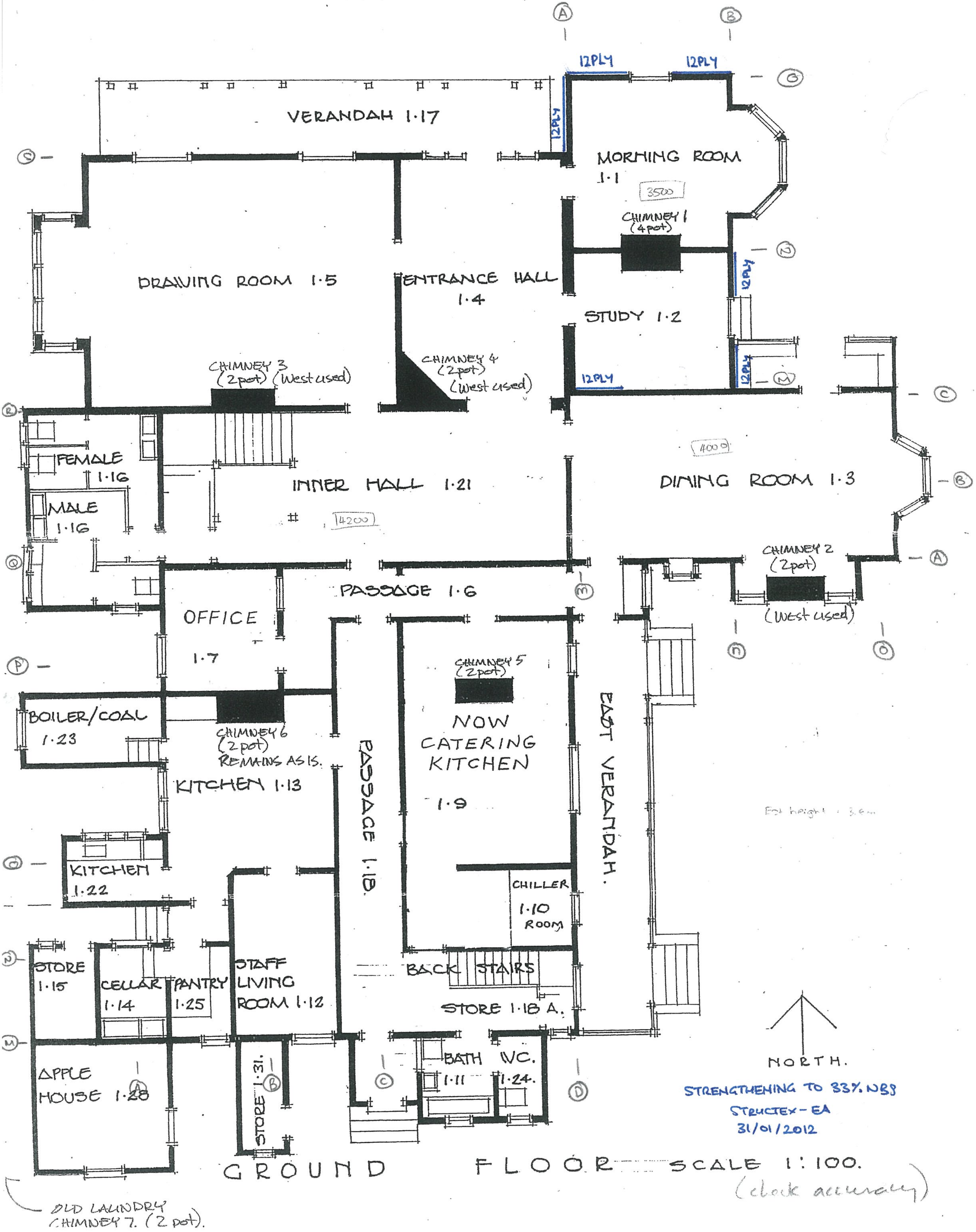

29 SECTION - Scale: 1:10




33 SECTION - Scale: 1:10

| issue | description | by | appd. | date | drawn | designed | approved | scales | client | project title | | drawing title | drawing no | project / issue |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | DM | EA | | 1:10 | INSIGHT UNLIMITED | RICCARTON HOUSE 16 KAHU ROAD | structex "Giving support a whole new meaning" www.structex.co.nz | CHIMNEY DETAILS | S2.10 | 5906 / A |

## Appendix F: Proposed strengthening work to 33%NBS



VERANDAH 1·17
MORNING ROOM 1·1
3500
CHIMNEY 1 (4 pot)
12PLY
12PLY
12PLY
12PLY
12PLY
12PLY
DRAWING ROOM 1·5
ENTRANCE HALL 1·4
STUDY 1·2
CHIMNEY 3 (2 pot) (West used)
CHIMNEY 4 (2 pot) (West used)
FEMALE 1·16
MALE 1·16
INNER HALL 1·21
4200
4000
DINING ROOM 1·3
CHIMNEY 2 (2 pot) (West used)
PASSAGE 1·6
OFFICE 1·7
CHIMNEY 5 (2 pot)
NOW CATERING KITCHEN 1·9
BOILER/COAL 1·23
CHIMNEY 6 (2 pot) REMAINS AS IS.
KITCHEN 1·13
PASSAGE 1·18
EAST VERANDAH.
KITCHEN 1·22
CHILLER 1·10 ROOM
STORE 1·15
CELLAR 1·14
PANTRY 1·25
STAFF LIVING ROOM 1·12
BACK STAIRS
STORE 1·18 A.
APPLE HOUSE 1·28
STORE 1·31.
BATH 1·11
W.C. 1·24.
NORTH.
STRENGTHENING TO 33% NBS
STRUCTEX - EA
31/01/2012
GROUND FLOOR SCALE 1:100.
(check accuracy)
OLD LAUNDRY CHIMNEY 7. (2 pot).