structex

Project 6009 – 10th April 2012

Lyttelton Recreation Centre

Detailed Engineering Evaluation Report
Stage 2: Quantitative Assessment

Contents

studio2 limited
5 norwich quay
po box 9
lyttelton
christchurch
new zealand

tel:+64 3 929 0253
studio2@structex.co.nz
www.structex.co.nz

10th April 2012

Lindsay Fleming
Christchurch City Council

Email: Lindsay.Fleming@CCC.Govt.NZ

Dear Lindsay,

Re: 1984 Lyttelton Recreation Centre
Detailed Engineering Evaluation – Quantitative Assessment

Introduction

Structex has been engaged to complete a detailed engineering evaluation for the 1984 Lyttelton Recreation Centre at 25 Winchester Street, Lyttelton, 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). This quantitative assessment follows a qualitative assessment for both the 1963 Community Centre and 1984 Recreation Centre, report dated 29th November 2011. 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) Estimates 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 33% and 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

The Lyttelton Recreation and Sports Centre has been damaged as a result of the recent Canterbury earthquakes. This report summarises our quantitative detailed engineering evaluation (DEE) of the 1984 Recreation Centre building. It follows a qualitative DEE for both the Lyttelton Recreation Centre and Community Hall, report dated 29th November 2012.

A seismic assessment of the Recreation Centre has been carried out in accordance with New Zealand Society for Earthquake Engineering (NZSEE) guidelines. In its current damaged state, the building has a seismic strength of 15% of New Building Standard (NBS), and is therefore considered to be earthquake-prone. Structural deficient elements include steel portal frames, portal frame connections to block walls, and block walls acting out-of-plane.

Repairs to earthquake damage that are required include: repairing/replacing GIB linings, re-fixing GIB linings to wall and ceiling framing, re-pointing crack concrete masonry, replacing roof bracing, replacing a timber beam, and possible reconstruction of the north-east squash court wall. Repairs to reinstate damaged retaining walls are also required.

In addition to repairs, this report outlines further work to strengthen the building to 33% and 67% of NBS.

Strengthening to 33% of NBS requires new roof and wall bracing to the squash court and gymnasium areas, new reinforced concrete columns at block wall corners, epoxied fixings to tie block wall corners together, new portal frame to diaphragm ties, and new floor to wall fixings.

Strengthening to 67% of NBS is similar to strengthening to 33%, except larger members are required for roof bracing, a 150PFC mullion in the gymnasium area, and more extensive wall to floor ties.

External retaining walls have been assessed. The northern concrete and stacked stone walls are non-engineered structures, and therefore are likely to be non-code compliant. If engineered structures are desired, these walls will likely require replacement. The northern timber pole retaining wall has been assessed as being 33% of NBS. It could be strengthened to 67% of NBS by installed additional 250SED timber poles.

This report does not constitute a full repair and strengthening specification. Further discussion with the building owner is required to determine the way forward. Once this has been decided, a detailed design and strengthening specification can be completed.

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

Refer Section 1.1 in previous "Stage 1: Qualitative Assessment report" dated 29th November 2011 for the "Lyttelton Recreation & Community Centre".

1.2 Christchurch City Council (CCC) Requirements for Earthquake-Prone Buildings

Refer Section 1.2 in previous "Stage 1: Qualitative Assessment report" dated 29th November 2011 for the "Lyttelton Recreation & Community Centre".

1.3 Recent Seismicity changes for Christchurch

Refer Section 1.3 in previous "Stage 1: Qualitative Assessment report" dated 29th November 2011 for the "Lyttelton Recreation & Community Centre".

2 Building Description

2.1 General description

Building name:	Lyttelton Recreation Centre
Address:	25 Winchester Street, Lyttelton, Christchurch
Building use:	Sports and recreation centre
Year Built:	1984
Legal description:	Lot 2, DP 43206
Number of storeys:	Two
Roof construction:	Light-weight metal cladding on timber purlins, on steel portal frames to gymnasium and squash court areas. Combination of light-weight metal cladding, and butynol on plywood, on timber framing to remaining areas.
Wall construction:	Timber framed with HardieFlex cladding and internal GIB linings to upper floor. Partially filled reinforced concrete masonry to lower floor. Steel portal frames in gymnasium and squash court areas.
Floor construction:	Timber flooring on timber joists to upper floor, except entrance foyer, which is concrete slab-on-grade. Timber flooring on timber joists to gymnasium on lower floor, concrete slab-on-grade elsewhere.
Subfloor construction:	Timber bearers on shallow piles under timber floored areas, concrete slab-on-grade with reinforced concrete strip footings elsewhere.
Approx. floor area:	1210m^2
Building Importance:	3 (NZS1170.0)

For the Recreation Centre, we have assumed a building occupancy of more than 300 people. This means this building is importance level 3 (IL3), as required by NZS1170.0.

As instructed we have ignored its Civil Defence Post-disaster function, which would require importance level 4 (IL4) to be adopted.

We have approached the Christchurch City Council on their requirements if the building were to be strengthened to IL4. As the building is likely to have been considered IL2 or IL3 when constructed, strengthening to IL4 would be considered a change of use, and the building would need to be strengthened to 100% of IL4 loads in accordance with Section 115 of the Building Act 2004.

If the building was IL4 when constructed, the Christchurch City Council Earthquake-prone Building policy applies, and 67% of NBS becomes the target level of strengthening. The council have clarified they are not in favour of this, but that this is the current legislation.

2.2 Structural System

Building:	1984 Recreation Centre
Gravity structural system:	Purlins spanning on to steel portal frames, or timber rafters seated on timber framed walls. Timber flooring over timber joists, either spanning over concrete block walls, timber beams fixed to block walls, or timber bearers. Timber bearers span over piles or onto concrete block walls. Concrete block walls are founded upon reinforced concrete strip footings.
Lateral load resisting system:	Plaster ceiling diaphragm spanning between plaster lined walls providing in-plane bracing at upper floor. Plaster ceiling diaphragm spanning between concrete block walls providing in-plane bracing at lower floor. In the gymnasium and squash court area, lateral resistance is provided by steel portal frames, and (perpendicular to portal frame lines) roof bracing spanning between concrete block walls.

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). This stage 2 report summarises our quantitative assessment.

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

(a) Visual inspections of the building carried out on the 2nd and 3rd November 2011; 10th , 16th and 27th February 2012; and 9th March 2012; which collectively included:
- The exterior from ground level
- The interior
- The roof top as visible from the flat roofed area

(b) Structural/architectural drawings obtained from the council property file. Original drawings were A0, however copies obtained were A3.

(c) Geotechnical investigation and report (See Appendix E) provided by Geoscience Consulting (NZ) Limited, which included:
- A desk study
- 3 no. hand auger boreholes and Scala Penetrometer tests
- 3 no. machine boreholes to approximately 10m depth, including Standard Penetrometer Test (SPTs) at 1.5m intervals.
- A visual inspection of damaged retaining walls

(d) The following on-site investigations which were carried by City Care:
- Removal of selected wall and ceiling linings to expose presence of diagonal steel brace in timber framed walls and upper floor connection to masonry block walls below.
- Removal of selected linings to expose portal frame baseplates fixed to the top of masonry block walls.
- Breaking out of concrete masonry into squash courts area to reveal nature of reinforcement and whether masonry was solid or partially filled.
- Excavation to reveal founding depth of timber pole retaining wall on north side.
- Excavation and drilling to reveal founding depth and thickness of concrete retaining wall on north side, followed by Ferroscanning and breaking out of concrete to determine reinforcing content.

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

Refer Section 4.1 in previous "Stage 1: Qualitative Assessment report" dated 29th November 2011 for the "Lyttelton Recreation & Community Centre".

In addition, our intrusive investigations revealed the following damage, which was previously concealed:

- Cracking to north-west masonry wall in gymnasium where portal frame column is seated on top of the wall.
- A masonry block at the north-east corner of the squash courts has dislodged where the portal frame is seated on top of the wall.
- Cracking and spalling damage to masonry walls in squash courts area, in at least two locations, where portal frame columns are seated on masonry walls.

4.2 Review of Building Performance

Refer Section 4.1 in previous "Stage 1: Qualitative Assessment report" dated 29th November 2011 for the "Lyttelton Recreation & Community Centre".

Below are additional comments following intrusive investigations:

- Intrusive investigations revealed unreliable return reinforcement around corners in masonry walls – reinforcement was sometimes present, or sometimes present but incorrectly detailed. Given this, the separation of return walls in the squash courts is likely the result of poor detailing.
- Damage to masonry walls where steel columns are seated on the wall was expected and observed. Fixings appeared to be inadequate, and engaged insufficient blockwork such that failure was likely to occur in the wall.

4.3 Critical Structural Weaknesses and Building Resilience

Refer Section 4.3 in previous "Stage 1: Qualitative Assessment report" dated 29th November 2011 for the "Lyttelton Recreation & Community Centre".

In addition, our intrusive investigations revealed the following critical structural weaknesses:

- Steel portal columns are poorly fixed to masonry walls. Typically baseplates are fixed to the wall with single M10/M12 anchors. However, in some cases these fixings are missing and the baseplate is instead welded to reinforcement cast into the wall below. Failure of these fixings could result in portal frames detaching from the wall below, causing local or total collapse of the gymnasium or squash court roof structure.
- Intrusive investigations revealed unreliable return reinforcement around corners in masonry walls – reinforcement was sometimes present, or sometimes present but incorrectly detailed. This could result in masonry walls detaching from returning walls as observed in the squash courts area. Worst case would be out-of-plane collapse of a wall should it detach completely.

4.4 Areas Requiring Further Investigation

Intrusive investigations to date of the northern concrete retaining wall have revealed the following:

- The concrete wall is 250-300mm thick.
- It is reinforced with R10s at 200-250mm centres each way on the near face, and therefore probably reinforced also on the far face.
- There is no toe or heel footing at the base of the wall.

Based on these findings, the wall appears to be a non-engineered structure. Further investigations behind the wall could be undertaken to determine if there is a heel footing higher up the wall or tie back anchors.

A decision should be made whether to:

- Continue with investigations and determine construction, or;
- Replace/retrofit the wall to provide code compliant retaining structure, or;
- Leave the wall in-place as it appears undamaged by the earthquakes.

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 19th May 2011. The building has been assessed as an Importance Level 3 (normal) building, assuming soil class C. A structural ductility of 1.25 was adopted for steel, concrete and concrete masonry elements. A structural ductility of 3 was adopted for plaster lined timber framed walls to the upper floor.

NZSEE guidelines (June 2006), and standards AS/NZS4229:1999, AS/NZS4230:2004, AS/NZS3404:1997 and AS/NZS3603:1993 have been used to assess the building capacity.

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.

AREA	ITEM	LEVEL	%NBS	
			N-S	E-W
Gymnasium	Steel portal frames	Upper floor	**15%**	**15%**
	Steel portal connections	Upper floor	**<33%**	**<33%**
	Block walls acting in-plane	Lower floor	100%	100%
	Block walls acting out-of-plane	Lower floor	41%	82%
	Roof bracing	Upper floor	-	**<33%**
	Foundations	Lower floor	100%	88%
Squash courts	Steel portal frames	Upper floor	100%	100%
	Steel portal connections	Upper floor	**30%**	50%
	Block walls acting in-plane	Lower floor	100%	100%
	Block walls acting out-of-plane	Lower floor	**<33%**	**<33%**
	Roof bracing	Upper floor	100%	100%
Office, conference & changing room area	Timber framed walls	Upper floor	100%	100%
	Roof diaphragm	Upper floor	87%	87%
	Block walls acting in-plane	Lower floor	94%	100%
	Block walls acting out-of-plane	Lower floor	46%	46%
Exterior landscape	Northern timber pole retaining wall		33%	-
	Northern concrete retaining wall		**<33%**[1]	-
	Northern and Eastern stacked stone retaining walls		**<33%**[1]	**<33%**[1]

[1] Current information suggests these structures are facing walls only, and therefore are likely to be non-code compliant retaining walls.

As the building has several critical elements with a seismic strength of less than 33% of NBS, the building is considered earthquake-prone.

6 Earthquake Repairs and Strengthening Work

This section describes repair works to restore the building to its pre-earthquake condition, and additional strengthening works required to bring the building up to 33% and 67% of NBS.

We highlight this report does not constitute a full repair or strengthening specification. Further discussion with the building owner is required to determine the way forward. Once this has been decided, a detailed design and strengthening specification can be completed.

6.1 Repairs

This section describes options of repair to restore the building to its pre-earthquake condition. Some of the work below will become redundant as a result of strengthening work described in the following sections.

These repairs are subject to change as the works proceed and as further information regarding existing construction and the extent of damage is revealed.

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 reinforced concrete masonry:

- Rake-out cracked mortar and re-grout/re-point.

Repair to north-east corner of squash courts:

- Undertake vertical alignment survey of wall.
- If the lean to the wall is within construction tolerance limits, break-out loose concrete, and patch repair spalled areas using Sika MonoTop-412N and Sika MonoTop-910N primer in accordance with Sika specifications. For smaller patch repairs, use Sikadur 41 with Sikadur 32 tie coat. Re-render and paint to match existing.
- If the lean is outside construction tolerance limits, attempt to re-align wall. Failing this the wall will need to be replaced.

Repair to gymnasium and squash court roof braces:

- Existing braces have yielded and stretched and require replacement.
- Remove braces and replace like-for-like. Ensure braces are taunt. Alternatively, replace with Reid braces of equivalent area.
- Reinstate ceilings.
- Note this work is likely to be superseded by strengthening work.

Repair to cracked/spalled concrete:

- Break-out loose concrete.
- If reinforcement is exposed, allow engineer to inspect condition of reinforcement. Repairs may be required.
- For corroded reinforcement, wire brush off loose material and spray with a rust convertor.
- Patch repair spalled areas using Sika MonoTop Structural Mortar and Primer in accordance with Sika specifications. For smaller patch repairs, use Sikadur 41 with Sikadur 32 tie coat.
- Seal cracks to concrete using a pressure-injected epoxy.

Repair to beam in squash court social room:

- Prop roof structure and replace split beam like-for-like.

Repair to plaster linings:

- Repair and/or replace damaged GIB wall and ceiling linings in accordance with GIB

recommendations. Refer GIB Bulletin "Guidelines for repairing GIB plasterboard linings in wind or earthquake damaged properties" (November 2011). This can be found online at www.gib.co.nz/earthquakebulletin.
- In addition, re-fix GIB wall and ceiling linings to timber framing in accordance with "GIB EzyBrace Systems" manual for GS1-N and GS2-N wall linings and Ceiling Diaphragms.
- Sand, prime and repaint over to match existing.

Repair to Hardieflex cladding:
- Replace fractured cladding panel on east face.
- Following repair to concrete masonry in north-east corner of squash courts, re-align timber battens and re-clad to match existing.
- Re-seal cracked panel joints with a flexible joint sealant.
- Repaint over to match existing.

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.
- Engage qualified plumber to repair leak to hot water cylinder and re-strap securely to wall.
- Engage qualified tradesperson to repair/replace butynol roofing as required.

Repairs to retaining walls:
- Northern timber pole retaining wall: Excavate backfill and re-lay free draining, well-graded, granular backfill to re-level footpath.
- Stacked stone retaining walls: Reinstate fallen blocks and re-grout. This repair should reinstate the strength of the wall prior to the earthquakes. However, if an engineered structure is desired, the wall will likely require replacement.

6.2 Strengthening to 33% NBS

In addition to repairs outlined in Section 6.1, the following work is required to strengthen the building to 33% of NBS. Refer marked-up drawings in Appendix G for further details:
- Install RB12 and 65x65x5SHS roof and wall bracing in the gymnasium area (SK-01).
- Install RB12 roof bracing in the squash courts area (SK-01 and SK-02).
- Cut and remove marked block wall corners. Box, reinforce and pour new concrete columns and tie into adjacent block walls. Reconnect portal frame columns to new concrete columns. (SK-01, SK-02 and SK-05)
- Install metal straps to tie gymnasium and squash court portal frames to adjacent upper floor and roof diaphragms (SK-03).
- Tie block wall corners with drilled and epoxied rods with angled and flat plates (SK-03 and SK-06).
- Provide new upper floor to block wall connections at marked locations (SK-03 and SK-07).

Current information suggests the northern concrete retaining wall and stacked stone retaining walls are non-engineered and therefore non-code compliant. If an engineered structure is desired, these walls will likely require replacement. As replacement structures will be new, these will need to be designed to 100% of NBS.

It may be possible to retrofit the northern concrete wall with tie back anchors. We suggest engaging a geotechnical engineer for specific engineering advice on this.

6.3 Strengthening to 67% NBS

In addition to repairs outlined in Section 6.1, the following work is required to strengthen the building to 67% of NBS. Refer marked-up drawings in Appendix H for further details:

- Install RB16, RB12 and 75x75x5SHS roof and wall bracing in the gymnasium area (SK-01).
- Install RB12 roof bracing in the squash courts area (SK-01 and SK-02).
- Cut and remove marked block wall corners. Box, reinforce and pour new concrete columns and tie into adjacent block walls. Reconnect portal frame columns to new concrete columns. (SK-01, SK-02 and SK-05)
- Install new 150PFC transom on top of south gymnasium block wall. Fix to portal frame columns and into wall below at regular centres.
- Install metal straps to tie gymnasium and squash court portal frames to adjacent upper floor and roof diaphragms (SK-03).
- Tie block wall corners with drilled and epoxied rods with angled and flat plates (SK-03 and SK-06).
- Provide new upper floor to block wall connections at marked locations (SK-03 and SK-07).
- The northern timber pole retaining wall has been assessed as being 33% of NBS. This could be strengthened to 67% of NBS, by installing additional 250SED timber poles down to 2.4m deep at 1200mm centres.

Current information suggests the northern concrete retaining wall and stacked stone retaining walls are non-engineered and therefore non-code compliant. If an engineered structure is desired, these walls will likely require replacement. As replacement structures will be new, these will need to be designed to 100% of NBS.

It may be possible to retrofit the northern concrete wall with tie back anchors. We suggest engaging a geotechnical engineer for specific engineering advice on this.

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

Refer Appendix B in previous "Stage 1: Qualitative Assessment report" dated 29th November 2011 for the "Lyttelton Recreation & Community Centre".

Additional photos following intrusive investigations:

Dislodgement of masonry block at connection with steel portal frame – north-east corner of squash courts.

Cracking and spalling to masonry at connection with steel portal frame – south-east corner of squash courts

Cracking to masonry wall at connection with steel portal frame – north-west corner of gymnasium

Cracking to masonry at connection with steel portal frame – squash court area

Appendix C: Photos of exposed construction

Diagonal steel brace present where detailed on original drawings.

Joists fixed to top plate with 2 skew nails. Top plate fixed to masonry wall below with bent D12 bar at 600mm centres.

South-east gymnasium portal column: No bolt fixing into masonry wall. Base plate welded to bar cast into the wall.

South-west gymnasium portal column: One M10 or M12 bolt fixing portal base plate to masonry wall. Base plate also welded to a bar, welded to another bar, and welded to a vertical bar cast into the wall.

Portal column in squash courts area: No nut to threaded rod cast into masonry wall. Base plate tack welded to threaded rod instead.

Portal column in squash courts area: Appears to be no bolt fixing into masonry wall below. Base plate welded to reinforcing bar cast into masonry wall instead.

Portal column north-west column of gymnasium: No bolt fixing base plate to masonry wall below.

South-west corner of squash courts area: No reinforcement tying external wall into return wall.

North wall of squash courts area: Return bar around corner not bent around vertical reinforcement.

Concrete retaining wall on north side. Drilling indicates the wall is 250mm-300mm thick and reinforced.

Excavation of the retaining wall footing revealed no toe footing. Drilling suggested there was no heel extending behind the wall either.

Timber poles embedded 1.85m into ground.

Appendix D: Marked-up sketches of damage

Refer Appendix C in previous "Stage 1: Qualitative Assessment report" dated 29th November 2011 for the "Lyttelton Recreation & Community Centre".

Appendix E: Geotechnical Report

GEOTECHNICAL INVESTIGATION

LYTTELTON RECREATION CENTRE, LYTTELTON

SUBMITTED TO:

EUVING AU

STUDIO2 LTD

PO BOX 9

LYTTELTON 8082

1 March 2012

DISTRIBUTION

2 Copies	–	Euving Au, Studio2 Ltd
1 Copy	–	Geoscience Consulting (NZ) Ltd

Geoscience Consulting (NZ) Limited
5 Norwich Quay, Lyttelton 8082, New Zealand
PO Box 110, Lyttelton 8841, New Zealand
T (+64) (3) 328 9012 F (+64) (3) 328 9013
www.nzgeoscience.co.nz

11114_2

ACENZ

CONTENTS

TABLES

FIGURES

APPENDICES

1 INTRODUCTION

Geoscience Consulting (NZ) Ltd (Geoscience) was requested by Studio2 Ltd to undertake a geotechnical investigation of the Lyttelton Recreation Centre, Lyttelton (herein referred to as 'the site') as outlined in our proposal (ref. P11146, dated 13th June 2011).

We understand that the Lyttelton Recreation Centre may require repairs and strengthening as the importance level of the building is under review owing to its use by civil defence services. Furthermore, we are aware that there are a number of retaining walls of various construction styles on the site and that you require a visual inspection following the 23rd of December 2011 earthquake event. Geoscience completed a geotechnical visual inspection (our ref. 11114_1, dated 16th of June 2011) of all the retaining walls following the 13th of June 2011 earthquake event.

Our scope of works for our geotechnical investigation included the following:

- Desktop study of relevant publically available geotechnical and geological publications;
- Three hand auger boreholes and Scala Penetrometer (Scala) tests across the site to confirm material types and strength characteristics;
- Technical supervision of three machine boreholes to approximately 10 m including Standard Penetrometer Tests (SPTs) at 1.5 m intervals and geotechnical logging of core samples; and
- Presentation of a report outlining our findings.

Our scope of works specifically excludes an assessment of the structural integrity of the buildings.

2 SITE DESCRIPTION

The Lyttelton Recreation Centre is located below Winchester Street on moderately sloping ground in Lyttelton (Figure 1). The centre has been constructed on a cut platform and includes two adjoining buildings, the Community Hall and the Gym/Squash Courts. The Hall is western building with the Gym and Courts on the east side. Vehicle access to the site is via an asphalt drive off from Canterbury Street. The drive provides access to a shingle carpark on the southern side of the centre.

The northern boundary on Winchester Street is the upslope side of the cut platform and a number of retaining walls support the ground above. On the east side of the centre there is the remains/debris from a basalt block retaining that failed following the 13th of June 2011 earthquake event.

Site photographs are presented in Appendix 1.

3 GEOLOGY

The site is mapped[1] as being underlain by wind-blown loess, overlying Lyttelton Volcanic Group bedrock.

The site is currently mapped[2] by the Canterbury Earthquake Recovery Authority (CERA) as being within the 'Green Zone' where dwellings are considered suitable for repair or rebuilding.

4 GEOHAZARDS

4.1 Seismicity

Historically, Christchurch City has been considered to be in a region of low concentrations of active faults and seismicity. However, the Canterbury region has recently had four earthquakes with magnitude greater than 6. As a result, there is a heightened level of seismic risk stemming from the recently discovered Greendale, Lyttelton and Port Hills Faults. The recent seismic activity in the Canterbury region is currently considered to have increased the probability of another large (M6.0-7.9) earthquake to 16%[3] between the time of writing and February 2013.

Preliminary mapping[4] of the recent faulting in Canterbury illustrates the approximate locations of the Greendale Fault and sub-surface Lyttelton Fault rupture, the distribution of associated aftershocks 16 months on from the 4th of September 2010 event, and known active faults in the Canterbury area. Large regional areas of faulting[1,5] namely the Ashley Fault, Porters Pass-Amberley Fault Zone, and the Hope and Alpine Faults, are further afield but present a high seismic hazard risk to the Christchurch area due to the anticipated size of earthquakes generated. The largest of these faults is the Alpine Fault, which has a return period of 250-300 years and is expected to produce a M8 earthquake. The last rupture on the Alpine Fault is believed to have occurred in 1717[6].

4.2 Liquefaction and Lateral Spreading

The site is shown on the Christchurch Liquefaction Hazard Map[7] to be located in the *"Port Hills – very low likelihood of liquefaction (area not studied)"*.

4.3 Rockfall Hazards

No rockfall is known to have affected the site as a result of the recent earthquakes and we consider rockfall risk at the site to be very low as there are no obvious rockfall sources nearby.

4.4 Slope Stability

No evidence of large scale instability was observed at the site and the Port Hills Geotechnical Group has not identified any large scale instability features that may affect the site (as of May 2011).

5 FIELD INVESTIGATIONS

5.1 Hand Auger Boreholes

Geoscience visited the site on the 21st of January 2011 and completed three hand auger boreholes (Figure 1) to depths of up to 1.6 m. Our investigations found the geology to be consistent with published mapping, as summarised in Table 1.

Table 1: Summary of Typical ShallowSubsurface Conditions

Depth (m)	Material Description	Material Type	Density/Consistency
0.0 – 0.2	SILT with some sand and gravel; dark brown.	TOPSOIL	Soft to Stiff
0.2 – 1.4+	SILT with minor sand and gravel; brown to black. Fine to coarse, angular to subrounded gravel.	FILL	Soft to Very Stiff

Groundwater was not encountered in the boreholes.

Full logs are presented in Appendix 2 and are written in accordance with the New Zealand Geotechnical Society 'Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes'[8].

5.2 Scala Penetrometer Testing

Scala tests were carried out at the hand auger borehole locations to a maximum depth of 1.2 m below ground level. The Scala tests were undertaken to assess the subsurface strength profile and to help determine if ground beneath the site meets the requirements of static "good ground", defined in NZS 3604:2011[9] as follows:

"Where the number of blows per 100 mm depth of penetration below the underside of the proposed footing at each test site exceeds:

- *5 down to a depth equal to twice the width of the widest footing; and*
- *3 at greater depths.*

Furthermore, the definition of "good ground" also excludes organic topsoil, soft or very soft peat, soft or very soft clay and / or uncertified fill below the depth of footing at any test site. Sites prone to liquefaction also do not meet under the definition of "good ground".

"Good ground" under static conditions was not encountered in our tests and the material sampled was identified as uncertified fill.

Scala results are presented with the borehole logs in Appendix 2.

5.3 Machine Boreholes

Following our site visit, three machine boreholes were drilled by Pro-Drill Auckland Ltd (Pro-Drill) to a maximum depth of 7.95 m and were terminated in bedrock. The results of the machine boreholes is summarised in Table 2.

Table 2: Summary of Machine Borehole Drilling

Average Depth (m)	Material Description	Material Type	Density/Consistency
0.0 – 2.0	Sandy GRAVEL, gravelly SILT, SILT and cobbles of BASALT; grey to brown.	FILL	Firm to Stiff
2.0+	Weathered BASALT and BASALT SCORIA. Completely weathered becoming moderately weathered at depth; brownish orange becoming very dark brown at depth. A layer of SILT [LOESS] was encountered in BH02 from 3.10-3.95 m.	LYTTELTON VOLCANIC GROUP	Very weak to Moderately Strong

Groundwater was not encountered in the boreholes and the test locations are presented in Figure 1.

Full logs are presented in Appendix 3 and are written in accordance with the New Zealand Geotechnical Society 'Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes'[8].

5.4 Engineering Geology Mapping

Engineering Geology mapping was undertaken at the site, with our observations outlined below:

- There are a number of retaining walls on the site of various construction styles. Of primary concern are the walls on the north boundary of the site that retain the ground up to Winchester Street, the wall on the east side of the centre that is within 2 m of the gym / squash courts and the south west wall adjacent to the community hall.
- The northern retaining is comprised of two, tiered walls. The upper wall is of timber post and panel construction (~1.7 m high) and the lower wall is concrete (~2.3 m high).

  The upper wall on the north side below Winchester Street does not appear to have been significantly deformed. There is minor rotation of the near vertical posts and some displacement of the horizontal elements. The asphalt pavement behind the upper wall has cracked and settled and the back fill behind the walls is visible. At the base of the wall there are small talus cones of granular backfill that have settled out from behind the wall as a result of earthquake shaking.

  The eastern most section (approximately 2 m) of the upper wall is a stacked basalt block wall. A number of blocks have been dislodged and the back fill has settled below the Winchester Street footpath. The footpath has been temporarily reinstated with a secured piece of ply and there is new asphalt above extending across the footpath.

  The lower concrete wall on the north side does not appear to have sustained any damage.
- The basalt block retaining wall on the east side of the centre is approximately 10 m long and has collapsed at its southern end. The debris remains and the subsurface material is exposed. Services for the centre, uncertified fill and two cavities (diameter up to 500 mm) are visible.
- The south west retaining wall is a timber wall that has been constructed as two tiers. The wall is approximately 10 m long and each tier is approximately 0.6 m high. There has been minor rotation and deformation of the upper tier and the lower tier does not appear to be damaged.

  Above the upper tier of the south west wall there are tension cracks that are up to 50 mm wide and within 800 mm of the community hall.
- The concrete footpaths on the east side of the centre are cracked up to 5 mm and we consider this to be consistent with shaking damage.
- There are 2-3 mm cracks in the concrete perimeter footing on the west side of the centre (i.e. the Community Hall).

6 CONCLUSIONS

The Lyttelton Recreation Centre has a number of retaining walls on the site. The upper northern walls below Winchester Street require reinstatement works while the lower concrete wall does not appear to have been affected by the recent earthquake events. The basalt block wall on the east side of the centre has failed and needs to be replaced. Tension cracks were observed above the south west timber wall and there has been minor deformation of the upper tier of the wall.

Minor shaking damage was observed in the form of cracks in the concrete paths on the east side of the centre.

The Centre is underlain by fill to approximately 2.5 m with a layer of very stiff loess to approximately 4 m depth with interlayered basalt and basalt scoria below the loess. The basalt and basalt scoria is completely weathered below the loess and becomes moderately weathered with depth. A cross section interpretation of our investigations is presented in Figure 2.

Groundwater was not encountered in the hand auger or machine boreholes.

7 RECOMMENDATIONS

Based on our site investigation and assessment we consider the Lyttelton Recreation Centre to be suitable for repair subject to the following recommendations.

7.1 Retaining Walls

WINCHESTER STREET UPPER RETAINING WALLS

The northern retaining walls below Winchester Street do not appear to have been significantly deformed however we recommend that they are inspected, and their designs checked, by a Structural Engineer.

- The backfill behind the upper timber retaining wall should be brought back to footpath level using free draining well graded granular fill.
- The basalt block wall at the eastern end of the upper retaining wall may either be repaired by replacing the basalt blocks, or replaced with a suitable timber or concrete structure using the design parameters below. Whilst replacing the blocks in this wall is unlikely to meet modern design codes, it is considered that once the blocks are replaced and mortar repaired, it is unlikely to have been significantly weakened by the earthquake events.

EASTERN RETAINING WALL

We understand that the eastern retaining wall does not support the gym/squash courts as the building foundation extends below the retaining wall. This wall should be replaced with a new, engineered structure. We note that this wall extends along eastern boundary under the deck of the neighbouring property and replacement of the wall will require consultation with the owners.

The existing fill below the wall is not suitable for the wall foundation and we recommend the following options, in conjunction with the design parameters set out below:

- Excavate and replace the existing fill with engineered, compacted fill consisting of well graded granular sand and gravel, then construct either a gravity or cantilever wall.
- Alternatively, it may be possible to leave the existing fill in place and construct a timber post and panel wall founded in bedrock at approximately 2.5 m depth.

SOUTH WEST RETAINING WALL

We understand that the south west wall supports the foundations of the community hall. The wall appears sound although we recommend that the wall is inspected, and the design checked, by a structural engineer. If the wall is deemed structurally sound and has been designed to support the building, then we recommend that the tension cracks are filled and the material compacted.

If the wall is no longer sound and/or not designed to support the building then the wall should be replaced with an engineered wall designed to support the community hall. In the case that the existing wall is not designed to support the hall, the foundations should be underpinned before removing the wall.

DESIGN PARAMETERS

1. New engineered fill may be assumed to have an unfactored ultimate bearing resistance of 550 kPa, assuming a 1 m wide strip footing at least 1 m deep. Walls may be designed assuming an active earth pressure coefficient (k_a) of 0.27 for engineered fill provided that a wall displacement of at least 2% of the wall height is possible. A passive earth pressure coefficient (k_p) of 3.7 may be assumed in the engineered fill in front of the walls.
2. Existing fill may be assumed to have an active earth pressure coefficient (k_a) of 0.36 provided that a wall displacement of at least 2% of the wall height is possible. A passive earth pressure coefficient (k_p) of 2.7 may be assumed in the fill in front of the walls. New wall foundations may not be placed on existing, non-engineered fill.

7.2 Foundation Repairs

We do not consider that the fill beneath the buildings is suitable for new foundations, however we have been told that the foundations have performed satisfactorily during the Canterbury earthquake sequence and that there is no evidence of settlement of the building. Based on this observation, it is likely that the foundations will continue to perform adequately in the future provided that the building loads are not increased.

If the foundation loads increase significantly, or if a guarantee of performance is required, it will be necessary to underpin the foundations to bedrock below the fill.

Foundations should be designed by a Chartered Professional Engineer practising in foundation design.

8 REFERENCES

1 Forsyth, P.J.; Barrell, D.J.A; Jongens, R. 2008: Sheet 16 - Geology of the Christchurch Area 1:250,000. Institute of Geological and Nuclear Sciences, Lower Hutt.

2 http://cera.govt.nz/maps/land-status

3 http://www.geonet.org.nz/canterbury-quakes/aftershocks/

4 http://www.geonet.org.nz/var/storage/images/media/images/news/2012/chch_seismicity_31_01_2012/59313-1-eng-GB/Chch_Seismicity_31_01_2012.jpg

5 Rattenbury, M.S.; Townsend, D.B.; Johnston, M.R., 2006: Sheet 13 - Geology of the Kaikoura Area 1:250,000. Institute of Geological and Nuclear Sciences, Lower Hutt.

6 Pettinga J.R., Yetton M.D., Van Dissen R.J., and Downes G., 2001: Earthquake Source Identification and Characterisation for the Canterbury Region, South Island, New Zealand, Bulletin of the New Zealand Society for Earthquake Engineering, Vol 34, No. 4, pp 282-317

7 Christensen, S. 2002: Christchurch Liquefaction Study – Stage II ECan Report No. U02/22.

8 New Zealand Geotechnical Society, 2005: Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes.

9 Standards Association of New Zealand, 2011: Timber Framed Buildings – New Zealand, NZS 3604:2011. Standards New Zealand, Wellington.

We also acknowledge the New Zealand GeoNet project and its sponsors EQC, GNS Science and LINZ, for providing data used in this report.

9 LIMITATIONS

(i) This report has been prepared for the use of our client, Studio 2 Ltd, their professional advisers and the relevant Territorial Authorities in relation to the specified project brief described in this report. No liability is accepted for the use of any part of the report for any other purpose or by any other person or entity.

(ii) Assessments made in this report are based on the ground conditions indicated from published sources, site inspections and subsurface investigations described in this report based on accepted normal methods of site investigations. Variations in ground conditions may exist between test locations and therefore have not been taken into account in the report.

(iii) This Limitation should be read in conjunction with the IPENZ/ACENZ Standard Terms of Engagement.

We trust that this information meets your current requirements. Please do not hesitate to contact the undersigned on 03 328 9012 if you require any further information.

For and on behalf of Geoscience Consulting (NZ) Ltd,

Catherine Loye
Engineering Geologist

Matt Wiley
Principal Engineering Geologist

GEOSCIENCE consulting
(NZ) LIMITED

FIGURES

Geoscience Consulting (NZ) Limited
5 Norwich Quay, Lyttelton 8062, New Zealand
PO Box 110, Lyttelton 8841, New Zealand
T (+64) (3) 328 9012 F (+64) (3) 328 9013
www.nzgeoscience.co.nz

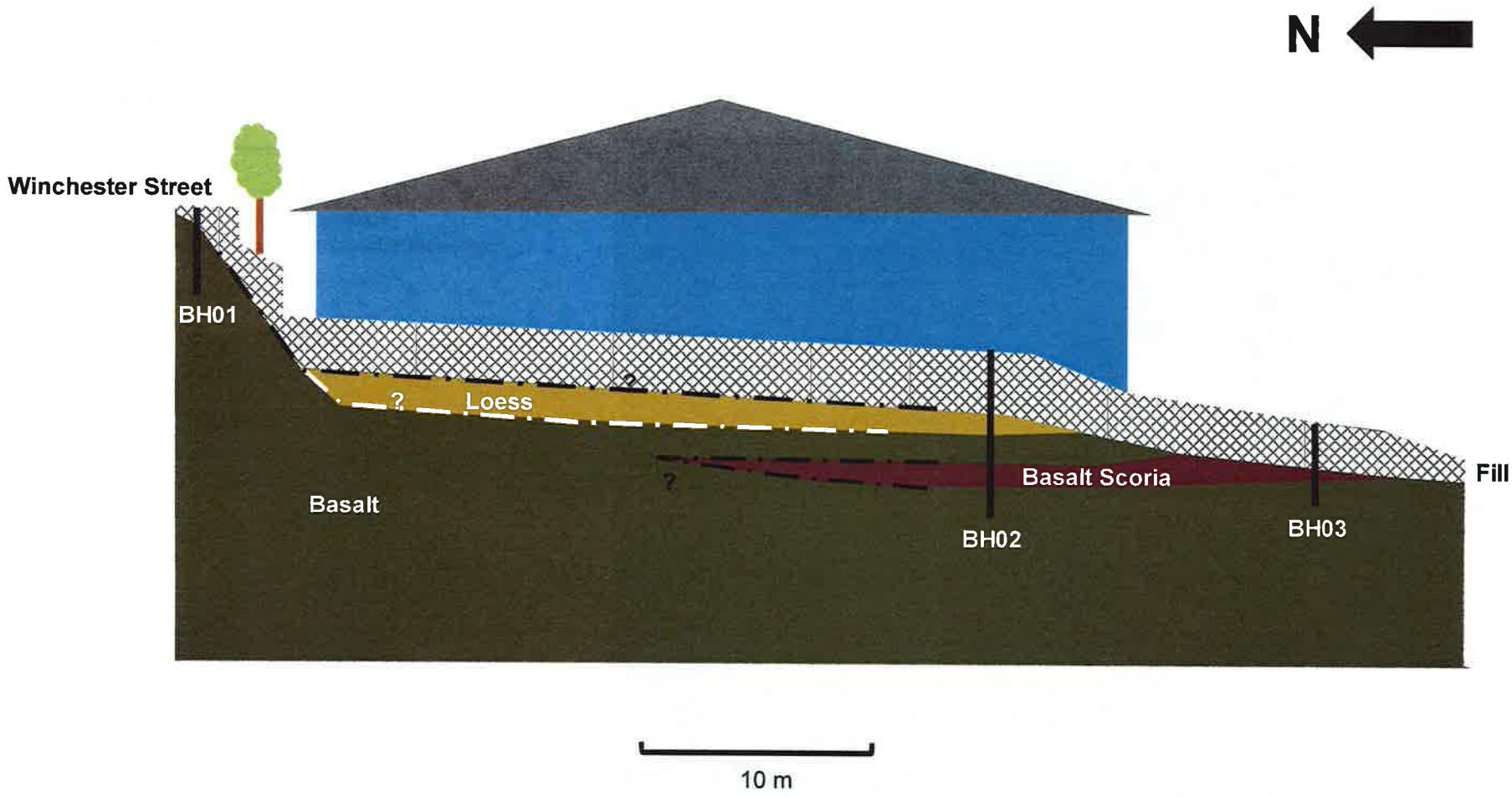
ACENZ

⊕ = Test Location

Note: - Aerial photo sourced from Koordinates.com
- Map sourced from Google Maps

GEOSCIENCE consulting (NZ) LIMITED

Date	Feb-11	**Client**	**Studio2 Limited**		
Drawn by	CL	**Project**	**Lyttelton Recreation Centre, Lyttelton**		
Approved by	MW	**Description**	**Site Location Plan**		
Scale	NTS	**Figure Number**	1	**Project Number**	11114_2



GEOSCIENCE consulting (NZ) LIMITED

Date	Feb-11	Client	Studio2 Limited		
Drawn by	CL	Project	Lyttelton Recreation Centre, Lyttelton		
Approved by	MW	Description	Cross Section		
Scale	As Shown	Figure Number	2	Project Number	11114_2

GEOSCIENCE consulting (NZ) LIMITED

APPENDIX 1

Site Photographs

Geoscience Consulting (NZ) Limited
5 Norwich Quay, Lyttelton 8062, New Zealand
PO Box 110, Lyttelton 8841, New Zealand
T (+64) (3) 328 9012 F (+64) (3) 328 9013
www.nzgeoscience.co.nz

ACENZ

Photo 1: Adjoined Community Hall (left) Gym / Squash Courts (right)

Photo 2: Northern retaining wall

Photo 3: Talus cones of granular fill at base of upper level of northern retaining wall

Photo 4: Cracks and subsidence above northern retaining wall

Photo 5: Failed basalt block wall on the east side

Photo 6: Tension cracks above south west wall

GEOSCIENCE consulting (NZ) LIMITED

Date taken	15/02/12	**Client**	**Studio2 Limited**		
Taken by	CL	**Project**	**Lyttelton Recreation Centre, Lyttelton**		
Approved by	MW	**Description**	**Site Photographs**		
Scale	N/A	**Photo No.**	1 to 6	**Project Number**	11114_2

GEOSCIENCE consulting (NZ) LIMITED

APPENDIX 2

Hand Auger Borehole Logs

Geoscience Consulting (NZ) Limited
5 Norwich Quay, Lyttelton 8062, New Zealand
PO Box 110, Lyttelton 8841, New Zealand
T (+64) (3) 328 9012 F (+64) (3) 328 9013
www.nzgeoscience.co.nz

ACENZ

GEOSCIENCE consulting (NZ) LIMITED

Engineering Log - Hand Auger Bore Hole

Hand Auger No. HA01
Sheet 1 of 1
Project No. 11114

Client: Studio 2 Limited
Principal: Euving Au
Project: Lyttelton Recreation Centre
Hand Auger Location: Refer to Site Location Plan

Date Started: 21/12/2011
Date Completed: 21/12/2011
Logged By: JC/HB
Checked By: NC

Diameter (mm): 50
Vane No.: N/A

Excavation Information				Material Substance						
Material	Water	Notes, samples, tests etc	Depth (m)	Graphic Log	Classification Symbol	Material Soil - soil type, colour, structure, grading, bedding, plasticity, sensitivity; Secondary and minor components Rock - colour, fabric, rock type; discontinuities; additional information	Moisture Condition	Consistency / Density Index	Shear Vane (Dial Readings kPa)	Scala (Blows/100mm)
TOPSOIL			0.2	TS	OL	SILT with trace sand; dark brown. Low plasticity. [TOPSOIL]	M	S-F		
			0.4	TS						
FILL			0.6		ML	SILT with some gravel; brown. Low plasticity; fine to coarse, angular gravel. [FILL]	W	F		
			0.8							
			1							

Scala (Blows/100mm): 4, 8, 12

EOH: 1.2 m
Termination: Practical refusal
Notes:
Hand auger and scala penetrometer tests met practical in fill.
No groundwater encountered.

GEOSCIENCE consulting (NZ) LIMITED

Engineering Log - Hand Auger Bore Hole

Hand Auger No. HA02
Sheet 1 of 1
Project No. 11114

Client: Studio 2 Limited
Principal: Euving Au
Project: Lyttelton Recreation Centre
Hand Auger Location: Refer to Site Location Plan

Date Started: 21/12/2011
Date Completed: 21/12/2011
Logged By: JC/HB
Checked By: NC

Diameter (mm): 50
Vane No.: N/A

Excavation Information				Material Substance						
Material	Water	Notes, samples, tests etc	Depth (m)	Graphic Log	Classification Symbol	Material Soil - soil type, colour, structure, grading, bedding, plasticity, sensitivity, Secondary and minor components Rock - colour, fabric, rock type; discontinuities; additional information	Moisture Condition	Consistency / Density Index	Shear Vane (Dial Readings kPa)	Scala (Blows/100mm) 4 8 12
FILL			0.2		ML	Gravelly SILT; brown with black mottles. Low plasticity; fine to medium, angular gravel. [FILL]	W	S		
			0.4							
			0.6							
			0.8							
			1							
			1.2		ML	SILT with minor sand; brownish black Low plasticity; fine sand. [FILL]	W	S		
			1.4							
			1.6		ML	SILT with trace sand; black brown. Low plasticity. [FILL]	W	S		

EOH: 1.6 m
Termination: Practical refusal
Notes:
Hand auger and scala penetrometer tests met practical in fill.
No groundwater encountered.

GEOSCIENCE Consulting (NZ) LIMITED

Hand Auger No. *HA03*

Sheet *1 of 1*

Project No. *11114*

Engineering Log - Hand Auger Bore Hole

Client: Studio 2 Limited

Principal: Euving Au

Project: Lyttelton Recreation Centre

Hand Auger Location: Refer to Site Location Plan

Date Started: *15/02/2012*

Date Completed: *15/02/2012*

Logged By: *CL/JC*

Checked By: *NC*

Diameter (mm): 50

Vane No.: N/A

Excavation Information				Material Substance						
Material	Water	Notes, samples, tests etc	Depth (m)	Graphic Log	Classification Symbol	Material Soil - soil type, colour, structure, grading, bedding, plasticity, sensitivity; Secondary and minor components Rock - colour, fabric, rock type; discontinuities; additional information	Moisture Condition	Consistency / Density Index	Shear Vane (Dial Readings kPa)	Scala (Blows/100mm) 4 8 12
TS					ML	Gravelly SILT; dark brown. Low plasticity; medium, sub-rounded gravel.	D	St-VSt		
FILL			0.2		ML	SILT with minor gravel, charcoal and brick fragments; light brown and dark brown. Low plasticity; fine to coarse, angular to sub-rounded gravel.	M-W	St-VSt		
			0.4							

EOH: 0.5 m

Termination: Practical refusal

Notes:

Hand auger and scala penetrometer tests met practical in fill.

No groundwater encountered.

TS = Topsoil

GEOSCIENCE consulting
(NZ) LIMITED

APPENDIX 3

Machine Borehole Logs

Geoscience Consulting (NZ) Limited
5 Norwich Quay, Lyttelton 8062, New Zealand
PO Box 110, Lyttelton 8841, New Zealand
T (+64) (3) 328 9012 F (+64) (3) 328 9013
www.nzgeoscience.co.nz

ACENZ

GEOSCIENCE consulting (NZ) LIMITED

Engineering Log - Machine Bore Hole

Bore Hole No. BH01
Sheet 1 of 1
Project No. 11114

Client: Studio 2 Limited
Principal: Euving Au
Project: Lyttelton Recreation Centre
Bore Hole Location: Refer to Site Location Plan

Date Started: 3/02/2012
Date Completed: 3/02/2012
Logged By: HA/CL
Checked By: NC

Machine Type: Edson
Contractor: ProDrill (Auckland) Ltd
Diameter (mm): 63
Drilling Method: Rotary Cored

Excavation Information				Material Substance						
Material	Water	Notes, samples, tests etc	Depth (m)	Graphic Log	Classification Symbol	Material: Soil - soil type, colour, structure, grading, bedding, plasticity, sensitivity; Secondary and minor components. Rock - colour, fabric, rock type; discontinuities; additional information	Moisture Condition	Consistency / Density Index	TCR (%)	SPT N-value (Uncorrected)
FILL					GP	Sandy medium to coarse GRAVEL; light grey and brown. Poorly graded, sub-rounded. [FILL]	D		60	
LYTTELTON VOLCANIC GROUP			1		-	Moderately weathered, orange brown BASALT; strong. Joints are smooth undulating and moderately widely spaced.			90	
		2.05m, RQD = 23% C	2		-	Slightly weathered, greyish orange BASALT; strong. Joints are smooth undulating and moderately widely spaced. Locally vesicular at 3.40 to 3.50m.			80	SPT 2m N=50 55mm pen.
			3		-	Vesicular from 3.40 to 3.50m.				SPT 3.5m N=26 450mm pen.

EOH: 3.95 m
Termination: Target depth
Notes:
Borehole terminated at 3.95m on Basalt.
Density not recorded from 0.0 to 1.70m due to disturbed sample.
Groundwater not recorded. C = Core.

GEOSCIENCE consulting (NZ) LIMITED

Engineering Log - Machine Bore Hole

Bore Hole No.	BH02
Sheet	1 of 2
Project No.	11114

Client: Studio 2 Limited
Principal: Euving Au
Project: Lyttelton Recreation Centre
Bore Hole Location: Refer to Site Location Plan

Date Started: 3/02/2012
Date Completed: 7/02/2012
Logged By: HA/CL
Checked By: NC

Machine Type: Edson
Contractor: ProDrill (Auckland) Ltd
Diameter (mm): 63
Drilling Method: Rotary Cored

Excavation Information

Material	Water	Notes, samples, tests etc	Depth (m)
FILL			1
			2
			3
LOESS			4
LVG			

Material Substance

Graphic Log	Classification Symbol	Material (Soil - soil type, colour, structure, grading, bedding, plasticity, sensitivity; Secondary and minor components. Rock - colour, fabric, rock type; discontinuities; additional information)	Moisture Condition	Consistency / Density Index	TCR (%)
	-	ASPHALT.			
	GW	Sandy fine to coarse GRAVEL; grey, Well graded, sub-rounded. [FILL]	D		60
	ML	Gravelly SILT with minor sand; brown and grey. Low plasticity; medium to coarse, subrounded gravel. [FILL]	M-W		50
	-	Moderately weathered, orange brown BASALT; strong. Joints are smooth undulating and moderately widely spaced. [FILL]	D		70
	ML	SILT; light brown. Low plasticity.	M	VSt	100
	-	Completely weathered, brown BASALT; very weak.			100

SPT N-value (Uncorrected)

25 50 75 | 10 20 30 40 50

SPT 2m
N=26
450mm pen.

SPT 3.5m
N=20
450mm pen.

GEOSCIENCE consulting (NZ) LIMITED

Engineering Log - Machine Bore Hole

Bore Hole No.	BH02
Sheet	2 of 2
Project No.	11114

Client: Studio 2 Limited
Principal: Euving Au
Project: Lyttelton Recreation Centre
Bore Hole Location: Refer to Site Location Plan

Date Started: 3/02/2012
Date Completed: 7/02/2012
Logged By: HA/CL
Checked By: NC

Machine Type: Edson
Contractor: ProDrill (Auckland) Ltd
Diameter (mm): 63
Drilling Method: Rotary Cored

Excavation Information				Material Substance							
Material	Water	Notes, samples, tests etc	Depth (m)	Graphic Log	Classification Symbol	Material: Soil - soil type, colour, structure, grading, bedding, plasticity, sensitivity; Secondary and minor components. Rock - colour, fabric, rock type; discontinuities; additional information	Moisture Condition	Consistency / Density Index	TCR (%)	SPT N-value (Uncorrected)	
LVG						BASALT continued.					
LYTTELTON VOLCANIC GROUP			6		-	Completely weathered, orange, brown and purple BASALT SCORIA; extremely weak.			100		SPT 5m, N=39 450mm pen.
									100		
					-	Moderately weathered, very dark brown BASALT; moderately strong. Joints are smooth undulating and widely spaced.	-		80		SPT 6.5m, N=50 25mm pen.
		C 6.95m, RQD = 64%	7		-	Highly weathered, reddish brown BASALT; moderately strong.	-		90		SPT 7.5m, N=50 75mm pen.

EOH: 7.95 m
Termination: Target depth
Notes:
Borehole terminated at 7.95m on Basalt.
Density not recorded from 0.0 to 2.75m due to disturbed sample.
Groundwater not recorded
LVG = Lyttelton Volcanic Group; C = Core

GEOSCIENCE consulting (NZ) LIMITED

Engineering Log - Machine Bore Hole

Bore Hole No.	BH03
Sheet	1 of 1
Project No.	11114

Client: Studio 2 Limited
Principal: Euving Au
Project: Lyttelton Recreation Centre
Bore Hole Location: Refer to Site Location Plan

Date Started: 7/02/2012
Date Completed: 7/02/2012
Logged By: HA/CL
Checked By: NC

Machine Type: Edson
Contractor: ProDrill (Auckland) Ltd
Diameter (mm): 63
Drilling Method: Rotary Cored

Excavation Information

Material	Water	Notes, samples, tests etc	Depth (m)
FILL			0
			1
			2
LYTTELTON VOLCANIC GROUP			3

Material Substance

Graphic Log	Classification Symbol	Material (Soil - soil type, colour, structure, grading, bedding, plasticity, sensitivity; Secondary and minor components. Rock - colour, fabric, rock type; discontinuities; additional information)	Moisture Condition	Consistency / Density Index	TCR (%)
	ML	Gravelly SILT with rootlets and building materials; brown. Low plasctity.	M		90
	-	Highly weathered, red BASALT. Large cobble as fill. [FILL]	D		
	ML	SILT with minor gravel and brick fragments; dark brown. Fine to coarse, angular to subangular basalt gravel. [FILL]	M	F-St	100
	ML	SILT with trace rootlets and plate fragments; brown with minor orange mottles. Low plasticity. [FILL]	M		100
	-	Highly weathered, brownish purple BASALT SCORIA; very weak.	-		100
	-	Moderately weathered, dark grey BASALT; moderately strong.	-		60

SPT N-value (Uncorrected)

25 50 75 | 10 20 30 40 50

SPT 2m
N=50
395mm pen.

SPT 3.5m
N=50
45mm pen.

EOH: 3.95 m
Termination: Target depth
Notes:
Borehole terminated at 3.95m on Basalt.
Density not recorded from 0.0 to 1.2 m due to disturbed sample.
Groundwater not recorded.

Appendix F: Supporting documentation for repair

GIB EzyBrace® System Specification – GS1-N

MAY 2011

Specification Code	Minimum Length (m)	Lining requirement
GS1-N	0.4	Any 10mm or 13mm GIB® Standard Plasterboard to one side only

WALL FRAMING

Wall framing to comply with;

- NZBC B1 - Structure; AS1 Clause 3 Timber (NZS3604)
- NZBC B2 - Durability AS1 Clause 3.2 Timber (NZS 3602)

Framing dimensions and height as determined by NZS 3604 stud and top plate tables for load bearing and non-bearing walls. The use of kiln dried machine stress graded timber is recommended.

BOTTOM PLATE FIXING

Timber Floor

Pairs of hand driven 100 x 3.75mm nails at 600mm centres; or

Three power driven 90 x 3.15 nails at 600mm centres.

Concrete floor

INTERNAL WALL BRACING LINES

In accordance with the requirements of NZS3604 for internal wall plate fixing or 75 x 3.8mm shot fired fasteners with 16mm discs spaced at 150mm and 300mm from end studs and 600mm centres thereafter.

EXTERNAL WALL BRACING LINES

In accordance with the requirements of NZS 3604 for external plate fixing.

WALL LINING

Any 10mm or 13mm GIB® Plasterboard lining.
Sheets can be fixed vertically or horizontally.
Sheet joints shall be touch fitted.
Use full length sheets where possible.

PERMITTED SUBSTITUTION

For permitted GIB® Plasterboard substitutions refer to Page 21 in GIB Ezybrace® Systems 2011 or GIB® Site Guide.

FASTENING THE LINING

Fasteners

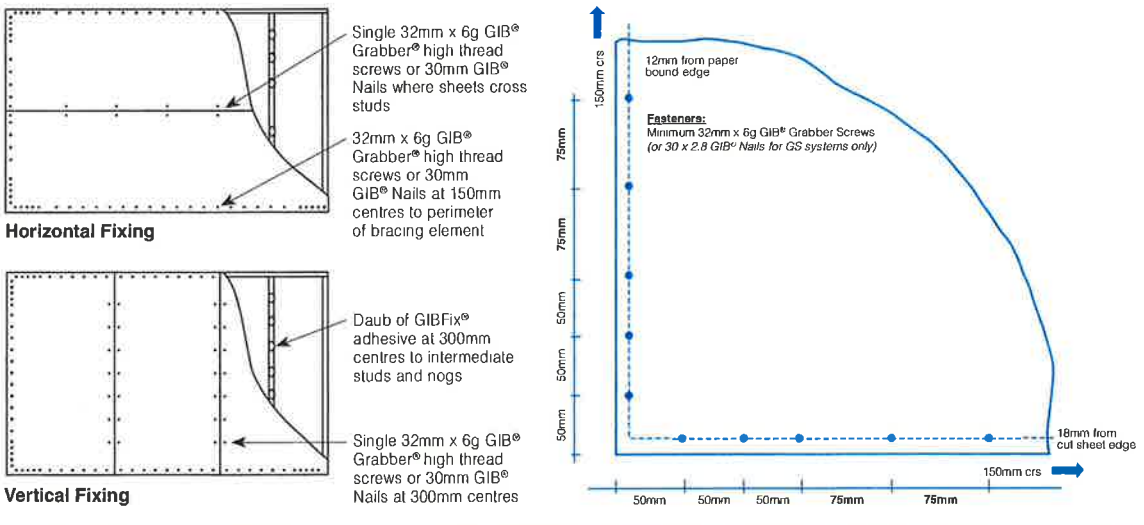
32mm x 6g GIB® Grabber® high thread screws; or
30mm GIB® Nails.

Fastener centres

50,100,150, 225, 300mm from each corner and 150mm thereafter around the perimeter of the bracing element.
For vertically fixed sheets place fasteners at 300mm centres to intermediate sheet joints.
For horizontally fixed sheets place single fasteners to the sheet edge where it crosses the stud.
Use daubs of GIB Fix® adhesive at 300mm centres to intermediate studs.
Place fasteners no closer than 12mm from paper bound sheet edges and 18mm from any sheet end or cut edge.

JOINTING

All fastener heads stopped and all sheet joints paper tape reinforced and stopped in accordance with the GIB® Site Guide.



In order for GIB® systems to perform as tested, all components must be installed exactly as prescribed. Substituting components produces an entirely different system and may seriously compromise performance. Follow the specifications. This Specification sheet is issued in conjunction with the publication GIB EzyBrace® Systems 2011.

GIB EzyBrace® System Specification – GS2-N

MAY 2011

Specification Code	Minimum Length (m)	Lining requirement
GS2-N	0.4	Any 10mm or 13mm GIB® Standard Plasterboard fixed to each side of the wall framing.

WALL FRAMING

Wall framing to comply with;

- NZBC B1 - Structure; AS1 Clause 3 Timber (NZS3604)
- NZBC B2 - Durability AS1 Clause 3.2 Timber (NZS 3602)

Framing dimensions and height as determined by NZS 3604 stud and top plate tables for load bearing and non-bearing walls. The use of kiln dried machine stress graded timber is recommended.

BOTTOM PLATE FIXING

Timber Floor

Pairs of hand driven 100 x 3.75mm nails at 600mm centres; or

Three power driven 90 x 3.15 nails at 600mm centres.

Concrete floor

INTERNAL WALL BRACING LINES

In accordance with the requirements of NZS3604 for internal wall plate fixing or 75 x 3.8mm shot fired fasteners with 16mm discs spaced at 150mm and 300mm from end studs and then 600mm centres thereafter.

WALL LINING

One layer 10mm or 13mm GIB® Plasterboard to each side of the wall.

Sheets can be fixed vertically or horizontally.

Sheet joints shall be touch fitted.

Use full length sheets where possible.

PERMITTED SUBSTITUTION

For permitted GIB® Plasterboard substitutions refer to Page 21 in GIB® Ezybrace Systems 2011 or GIB® Site Guide.

FASTENING THE LINING

Fasteners

32mm x 6g GIB® Grabber® high thread screws; or

30mm GIB® Nails.

Fastener centres

50,100,150, 225, 300mm from each corner and 150mm thereafter around the perimeter of the bracing element.

For vertically fixed sheets place fasteners at 300mm centres to intermediate sheet joints.

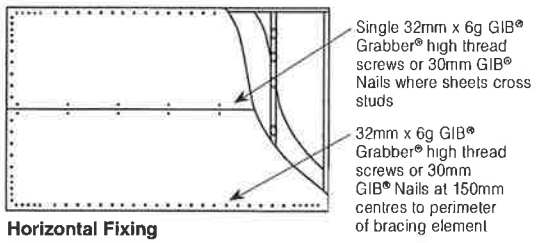
For horizontally fixed sheets place single fasteners to the sheet edge where it crosses the stud.

Use daubs of GIB Fix® adhesive at 300mm centres to intermediate studs.

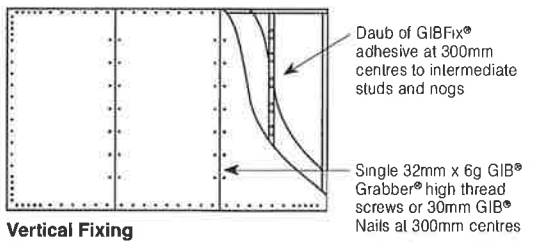
Place fasteners no closer than 12mm from paper bound sheet edges and 18mm from any sheet end or cut edge.

JOINTING

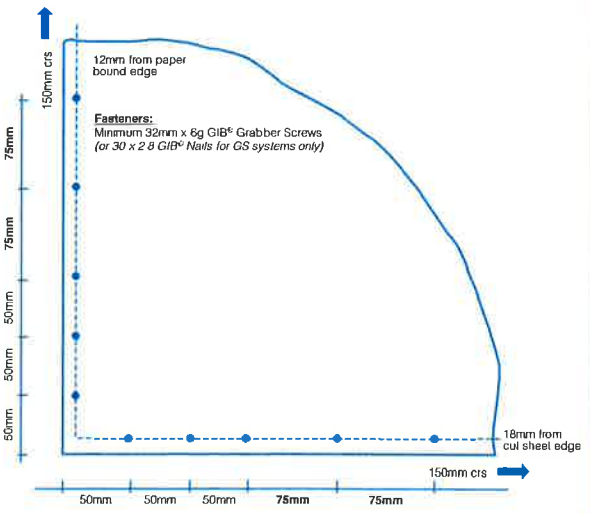
All fastener heads stopped and all sheet joints paper tape reinforced and stopped in accordance with the GIB® Site Guide.



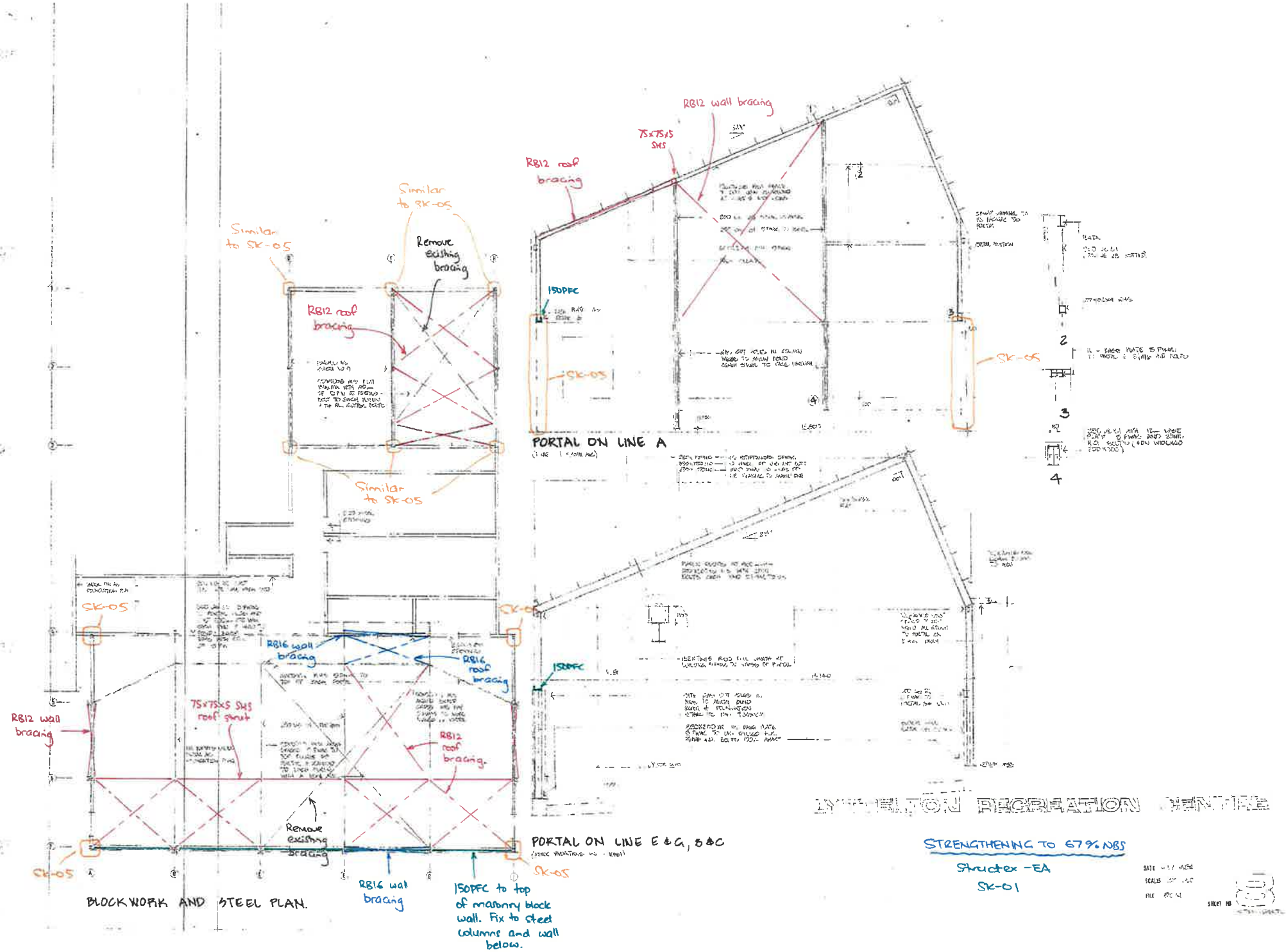
Horizontal Fixing



Vertical Fixing



In order for GIB® systems to perform as tested, all components must be installed exactly as prescribed. Substituting components produces an entirely different system and may seriously compromise performance. Follow the specifications. This Specification sheet is issued in conjunction with the publication GIB EzyBrace® Systems 2011.



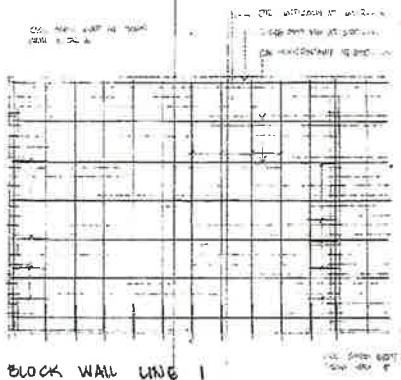
HAMILTON RECREATION CENTRE

STRENGTHENING TO 67% NBS

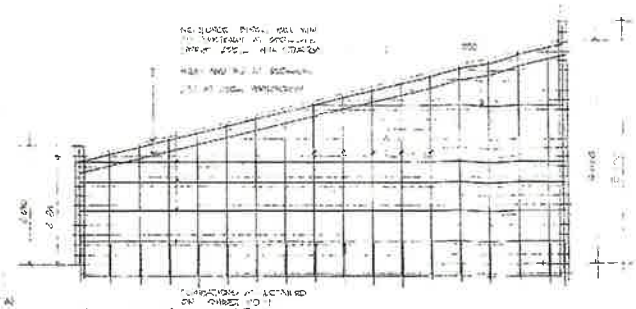
Structex -EA

SK-01

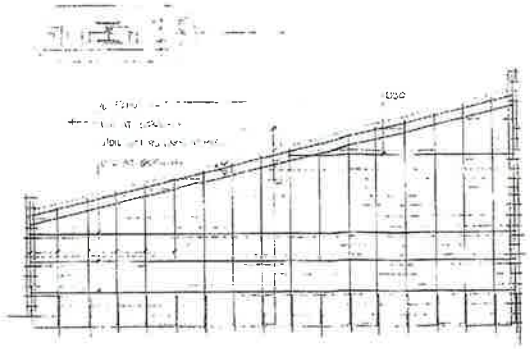
Appendix G: Strengthening to 33% of NBS



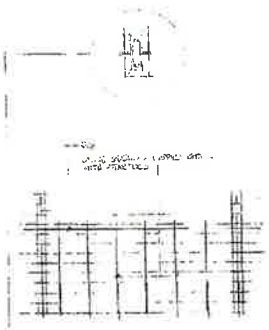
BLOCK WALL LINE 1



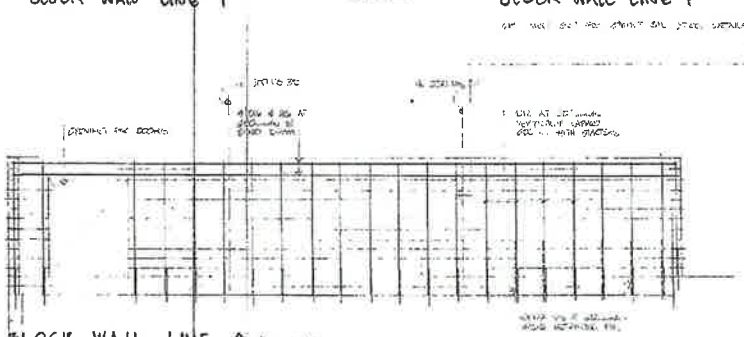
BLOCK WALL LINE F



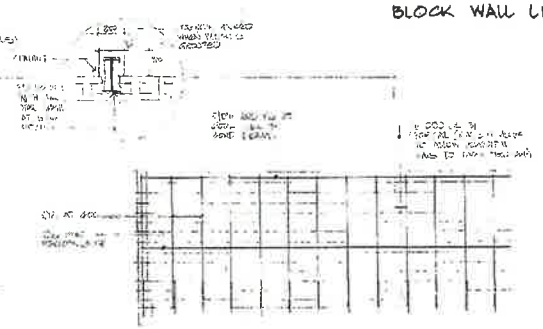
BLOCK WALL LINE D



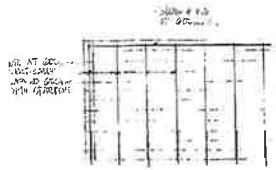
BLOCK WALL LINE H



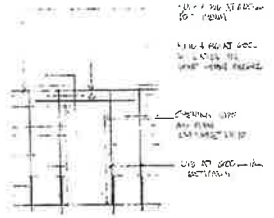
BLOCK WALL LINE A



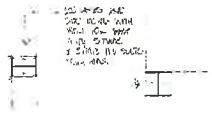
BLOCK WALL LINE 7

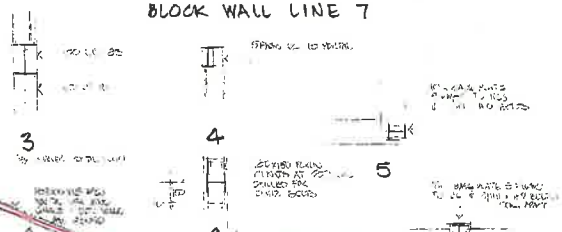


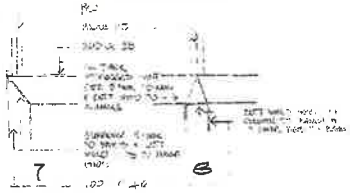
TYPICAL WALL

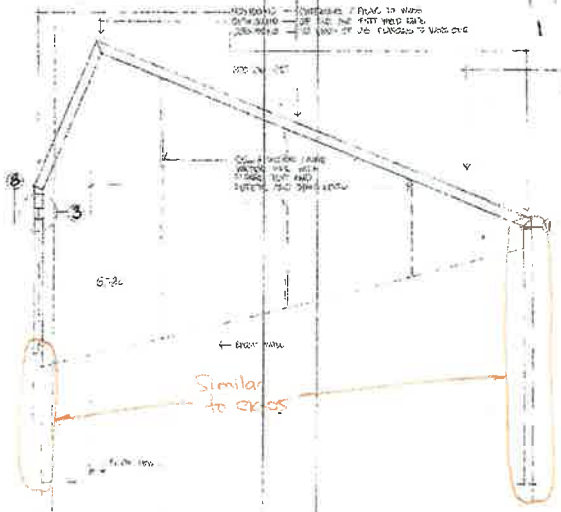


TYPICAL OPENING

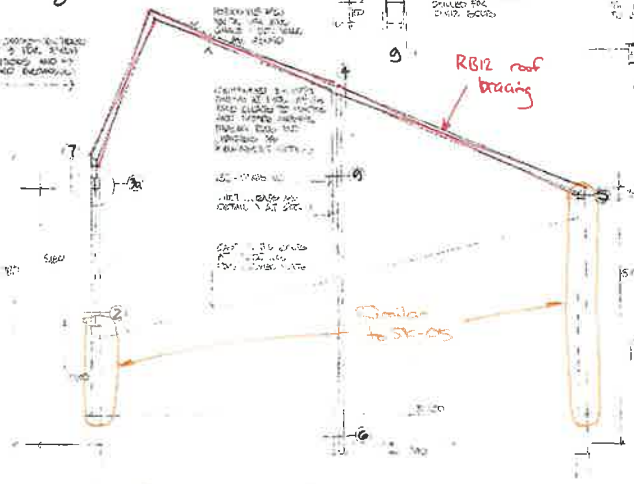








PORTAL ON LINE F



PORTAL ON LINE D

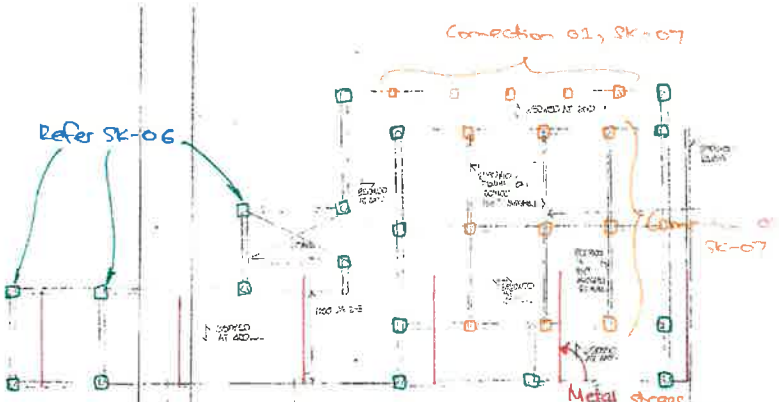
·NOTE·

LYTTELTON RECREATION CENTRE

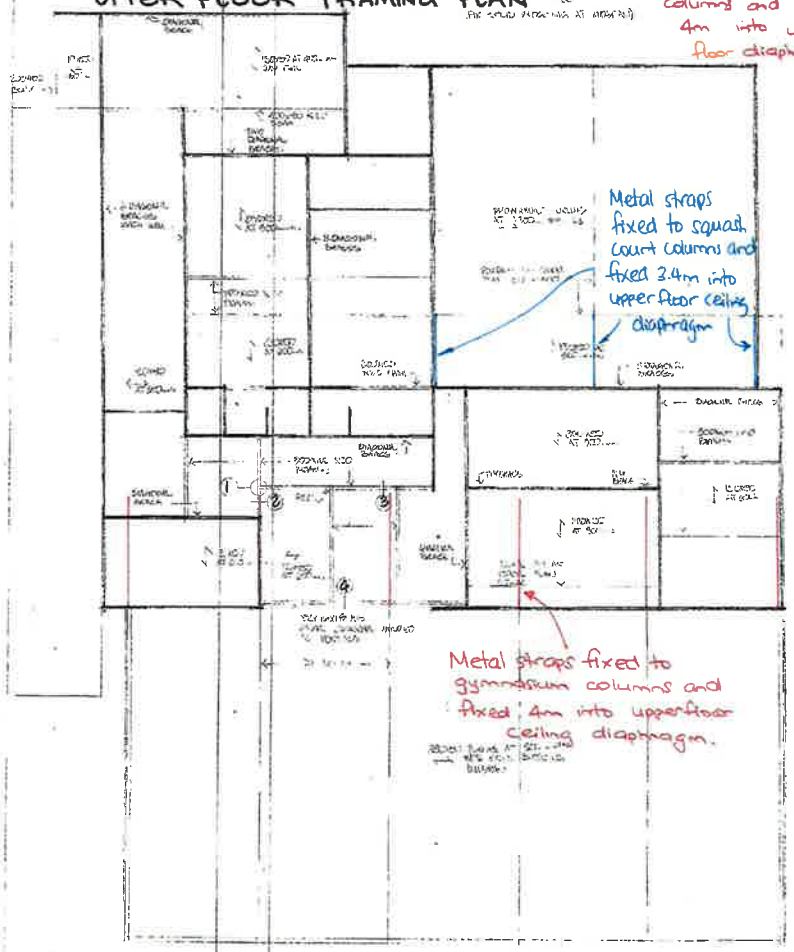
STRENGTHENING TO 67% NBS

Structex – EA

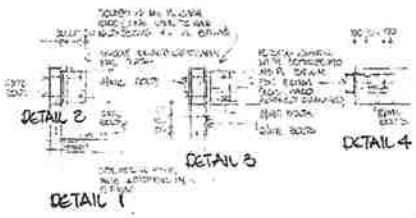
SK-02



UPPER FLOOR FRAMING PLAN



ROOF FRAMING PLAN & WALL BRACING



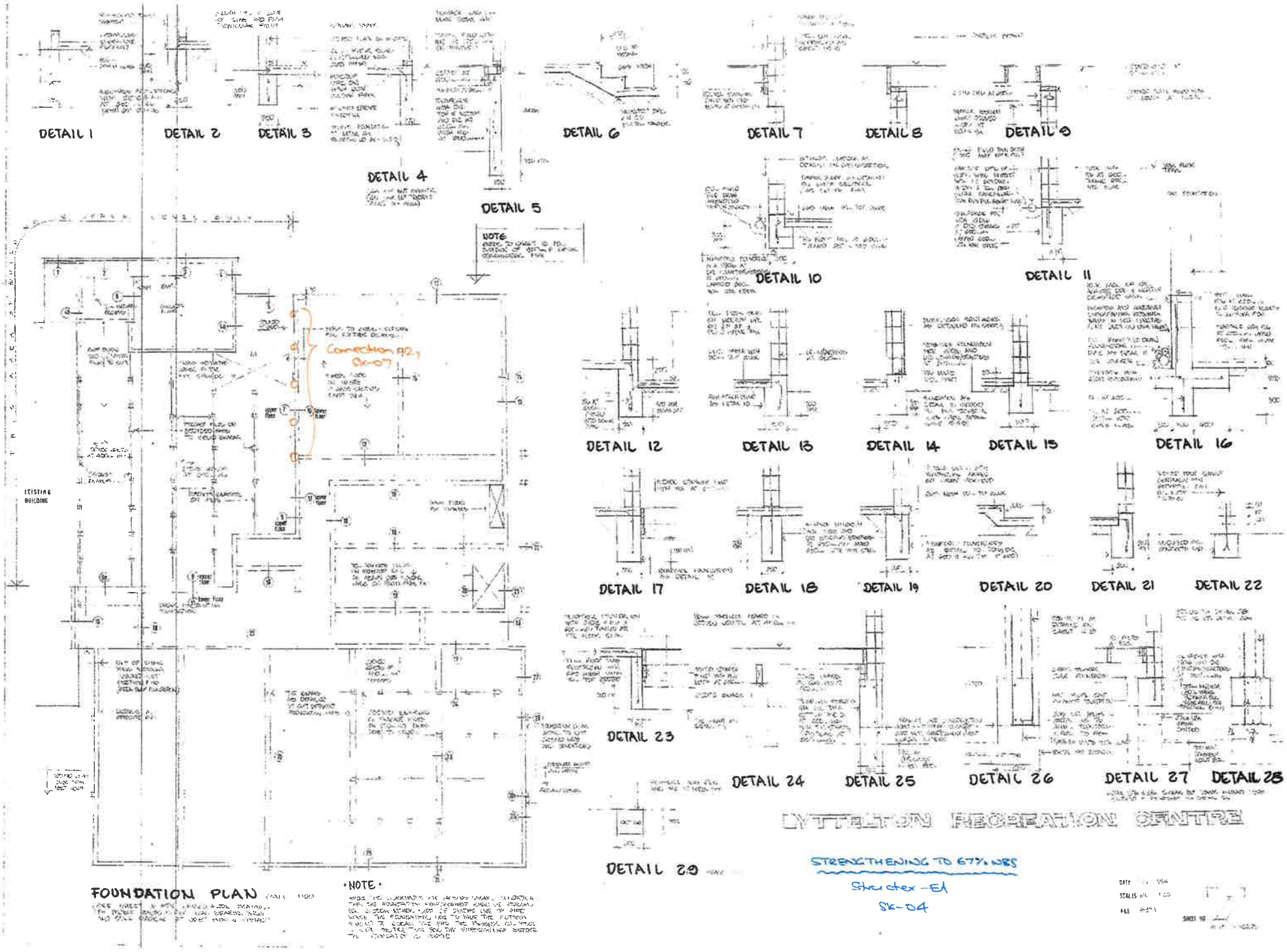
ROOF PLAN

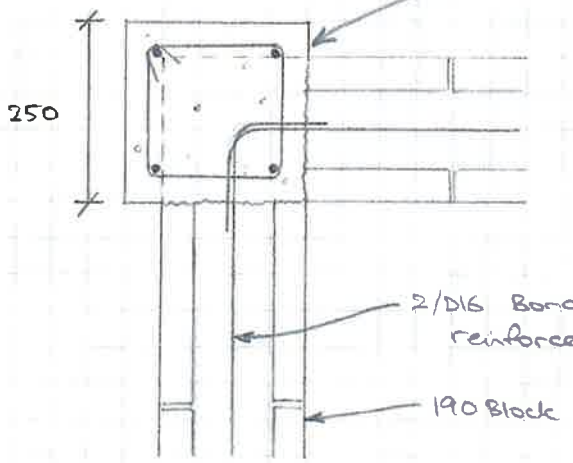
LYTTELTON RECREATION CENTRE

STRENGTHENG TO 67% NBS

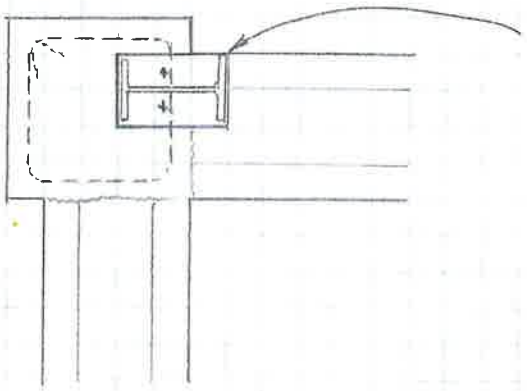
Structex - EA

SK-03


DETAIL 1
DETAIL 2
DETAIL 3
DETAIL 4
DETAIL 5
DETAIL 6
DETAIL 7
DETAIL 8
DETAIL 9
DETAIL 10
DETAIL 11
DETAIL 12
DETAIL 13
DETAIL 14
DETAIL 15
DETAIL 16
DETAIL 17
DETAIL 18
DETAIL 19
DETAIL 20
DETAIL 21
DETAIL 22
DETAIL 23
DETAIL 24
DETAIL 25
DETAIL 26
DETAIL 27
DETAIL 28
DETAIL 29
NOTE
EXISTING BUILDING
Correction 02, SK-07
FOUNDATION PLAN
•NOTE•
LYTTELTON RECREATION CENTRE
STRENGTHENING TO 67% NBS
Structex - EA
SK-04

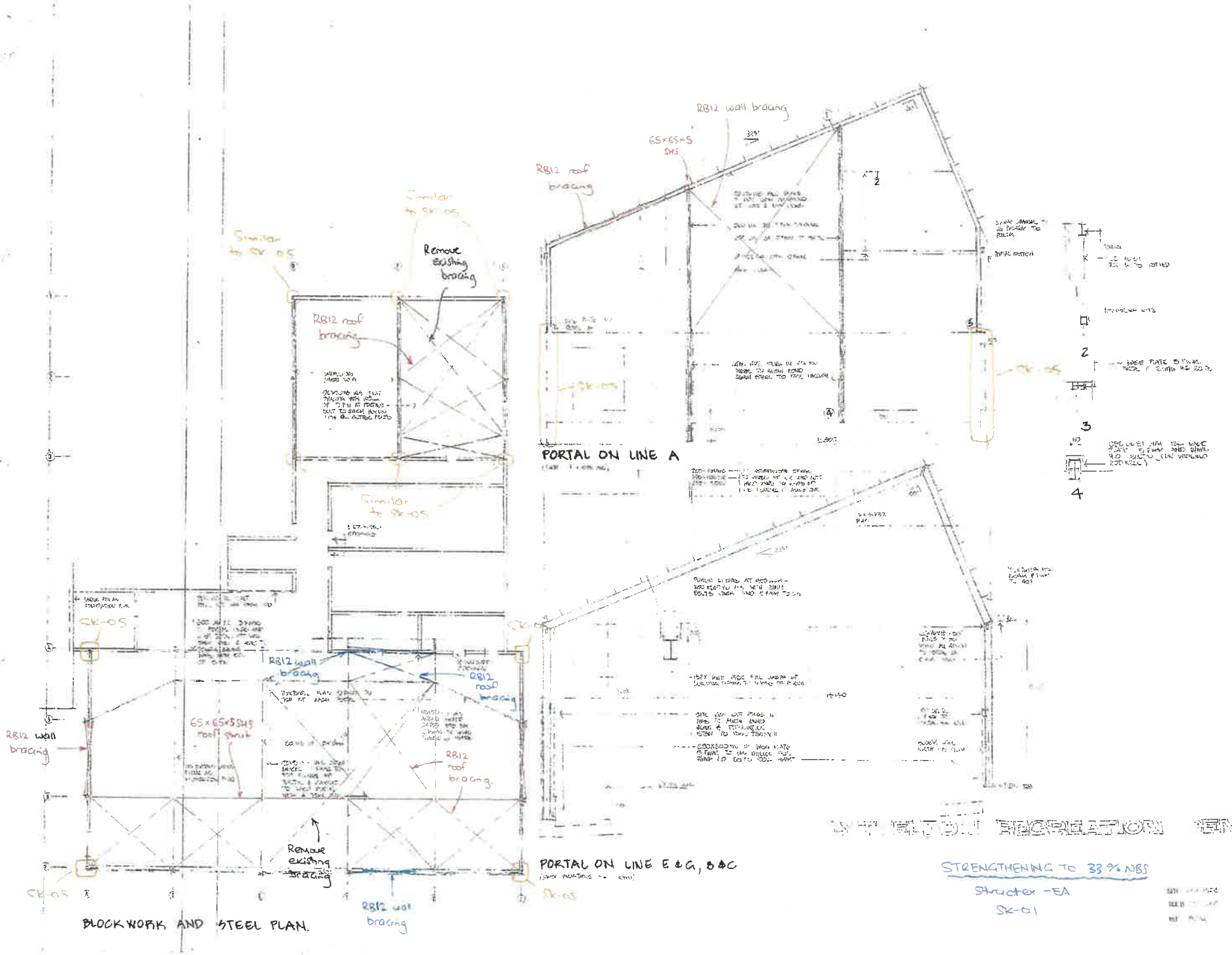


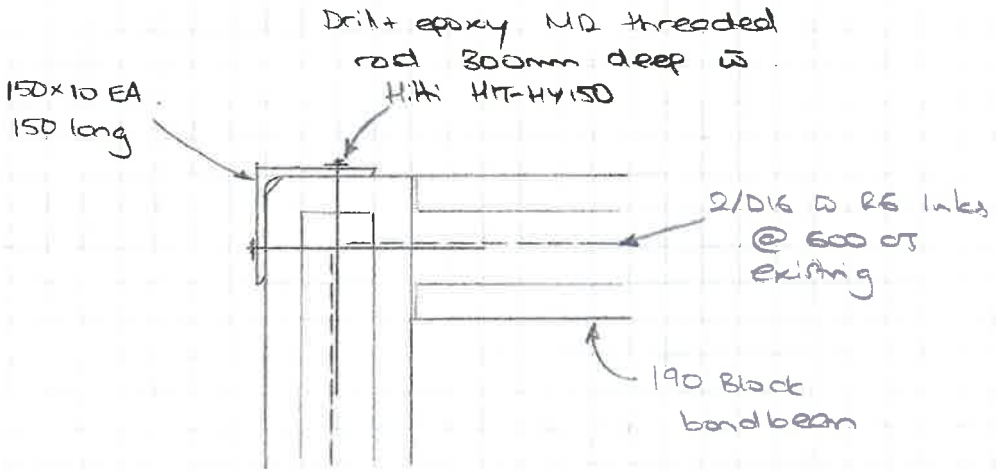
PLAN SECTION



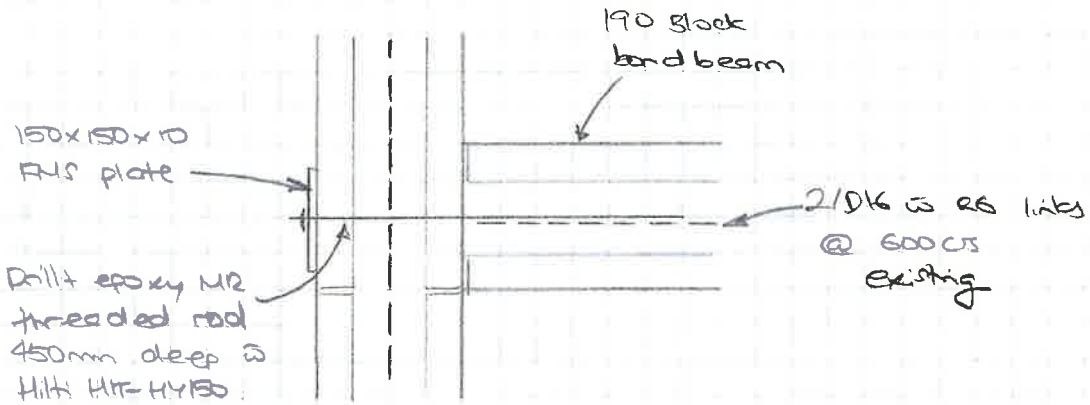
PLAN

Appendix H: Strengthening to 67% of NBS

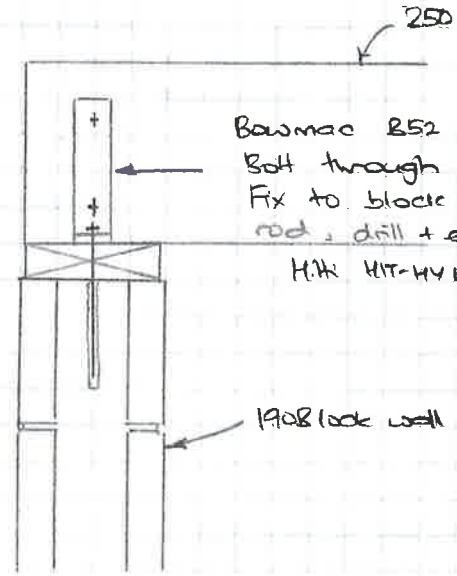

RB12 wall bracing
65x65x5 SHS
RB12 roof bracing
Similar to SK-05
Remove existing bracing
RB12 roof bracing
Similar to SK-05
PORTAL ON LINE A
SK-05
RB12 wall bracing
RB12 roof bracing
65x65x5 SHS roof strut
RB12 wall bracing
RB12 roof bracing
Remove existing bracing
SK-05
SK-05
RB12 wall bracing
PORTAL ON LINE E & G, B & C
BLOCKWORK AND STEEL PLAN.
STRENGTHENING TO 33% NBS
Structex - EA
SK-01



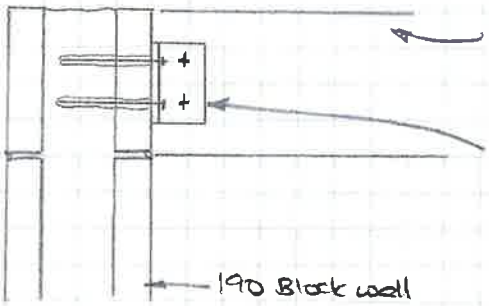
L-SHAPE CORNER TIE



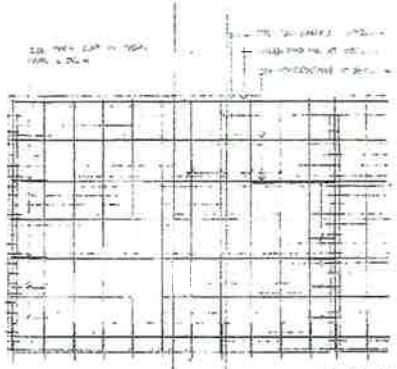
T-SHAPE CORNER TIE



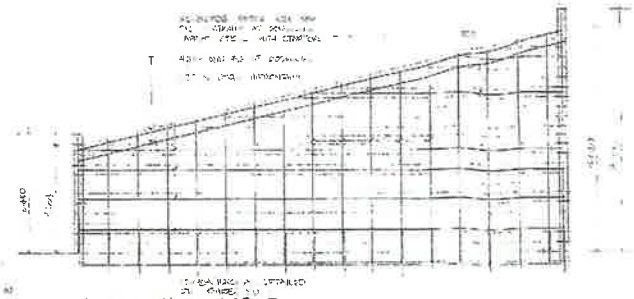
FLOOR-WALL CONNECTION 01



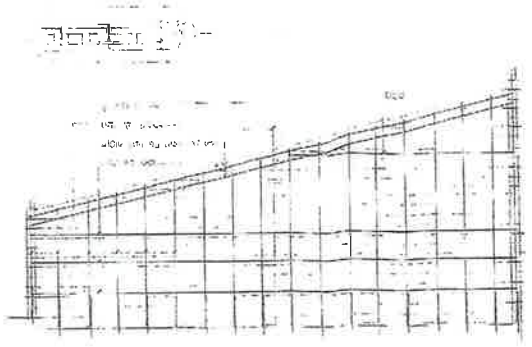
FLOOR-WALL CONNECTION 02



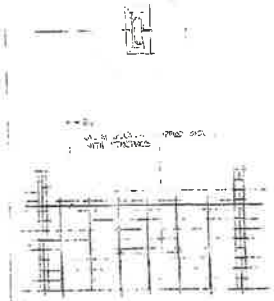
BLOCK WALL LINE 1



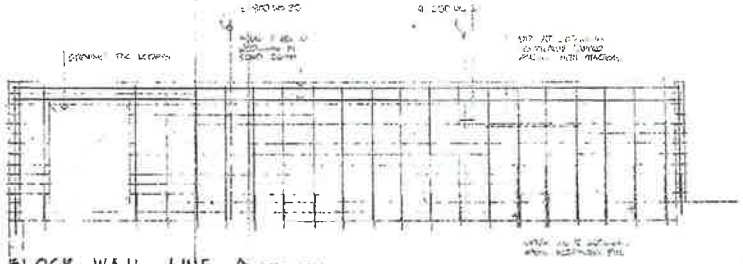
BLOCK WALL LINE F



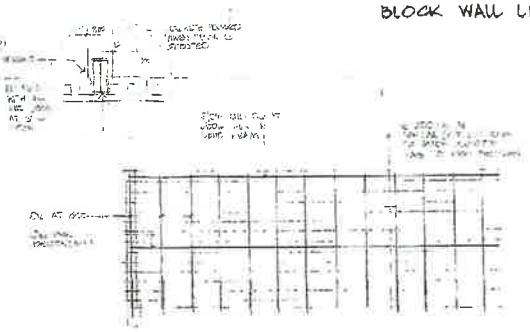
BLOCK WALL LINE D



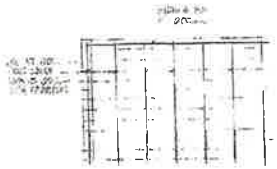
BLOCK WALL LINE H



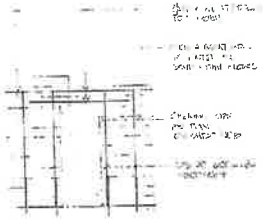
BLOCK WALL LINE A



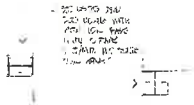
BLOCK WALL LINE 7

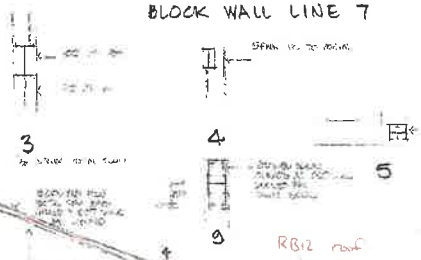


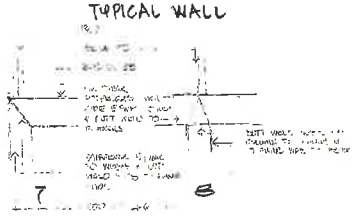
TYPICAL WALL

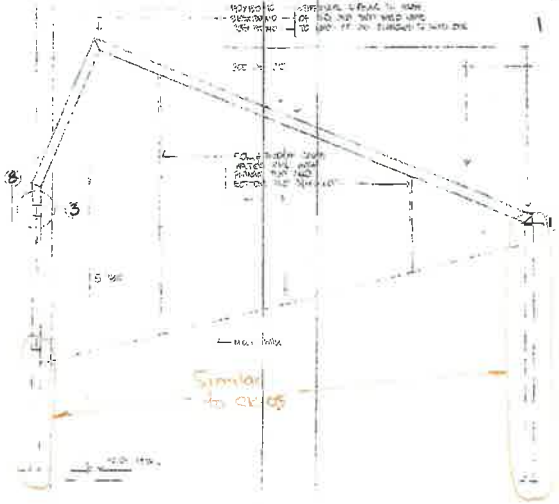


TYPICAL OPENING

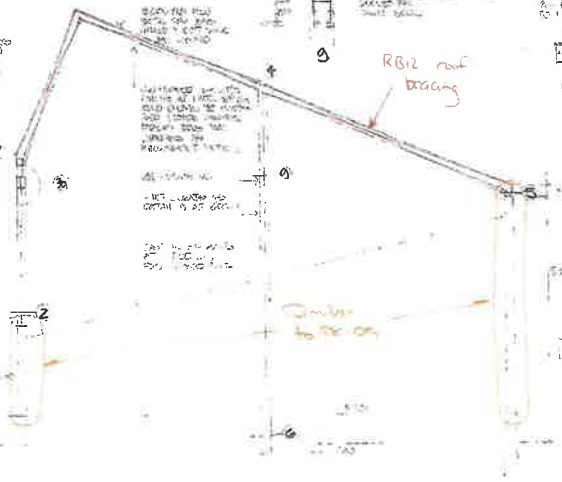








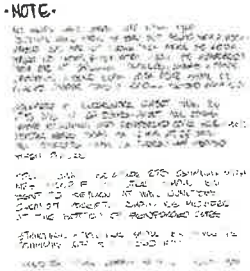
PORTAL ON LINE F



RB12 roof decking

PORTAL ON LINE D

·NOTE·

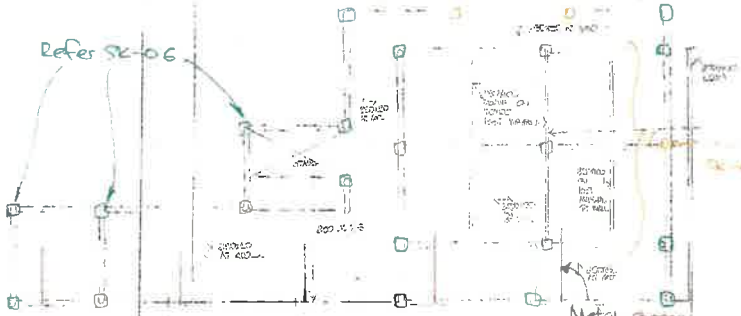


[illegible] RECREATION CENTRE

STRENGTHENING TO 33% NBS

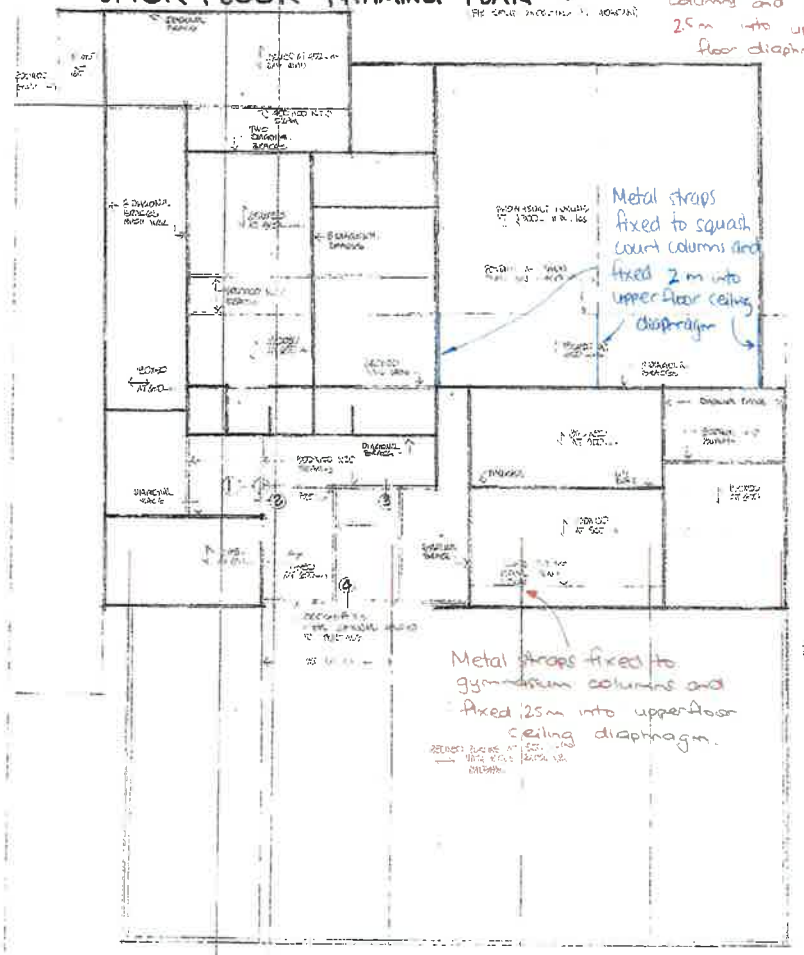
Struct ex - EA

SK-02

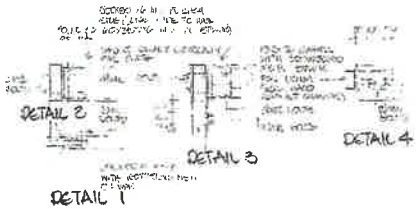


UPPER FLOOR FRAMING PLAN

Metal straps fixed to gymnasium column and fixed 25m into upper floor floor diaphragm



ROOF FRAMING PLAN & WALL BRACING



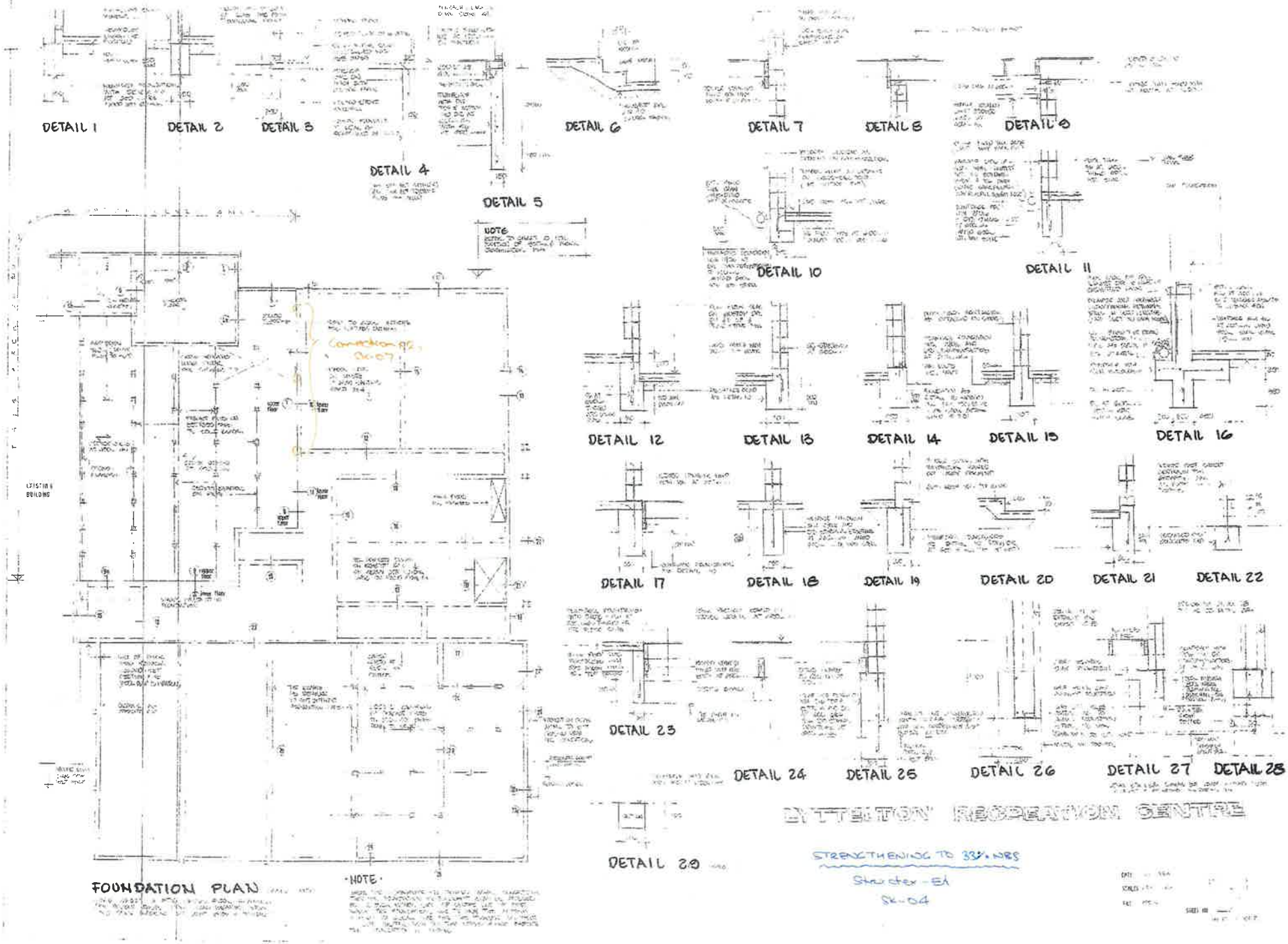
ROOF PLAN

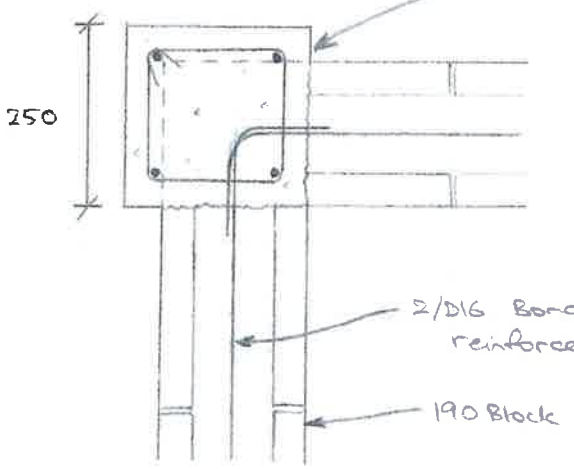
LATTELTON RECREATION CENTRE

STRENGTHENG TO 33% NBS

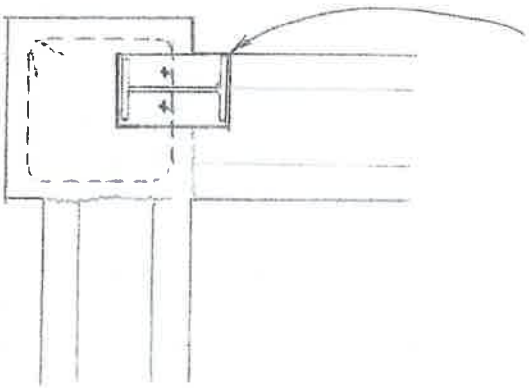
Structex - EA

SK-03

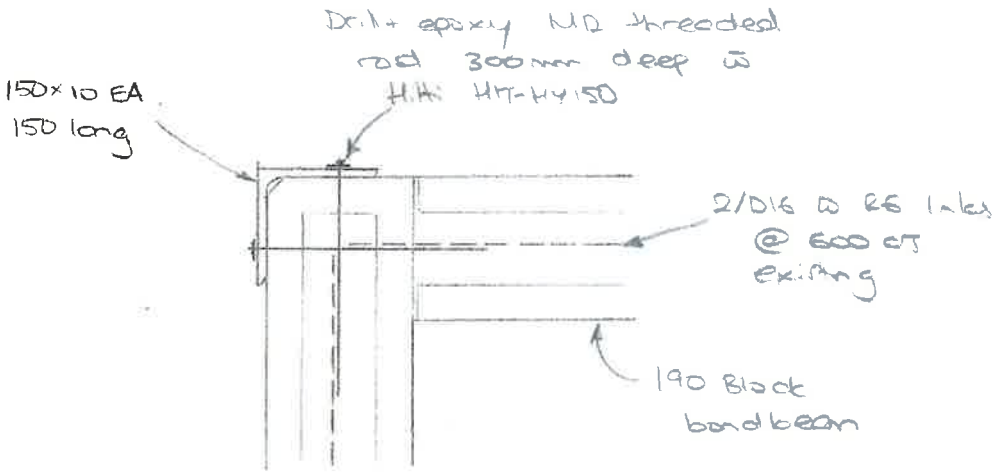

DETAIL 1
DETAIL 2
DETAIL 3
DETAIL 4
DETAIL 5
DETAIL 6
DETAIL 7
DETAIL 8
DETAIL 9
DETAIL 10
DETAIL 11
DETAIL 12
DETAIL 13
DETAIL 14
DETAIL 15
DETAIL 16
DETAIL 17
DETAIL 18
DETAIL 19
DETAIL 20
DETAIL 21
DETAIL 22
DETAIL 23
DETAIL 24
DETAIL 25
DETAIL 26
DETAIL 27
DETAIL 28
DETAIL 29
NOTE
EXISTING BUILDING
FOUNDATION PLAN
NOTE
STRENGTHENING TO 33% NBS
Structex - EA
SK-04



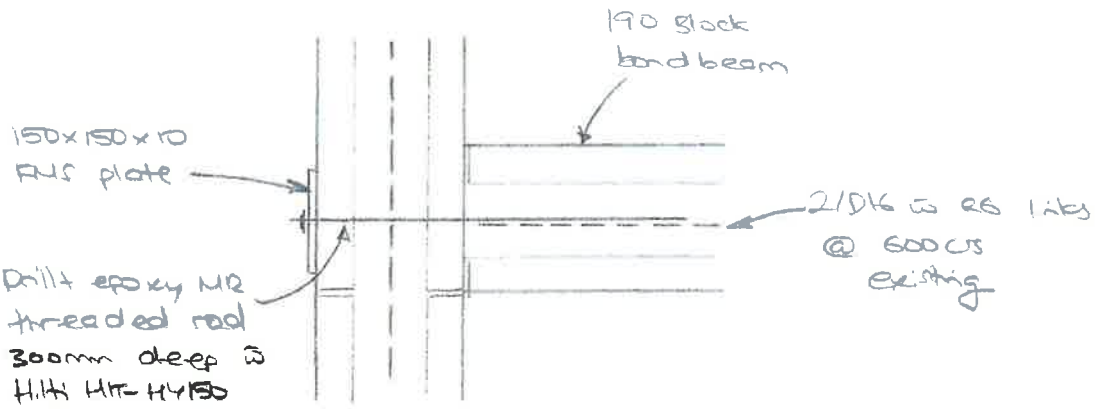
PLAN SECTION



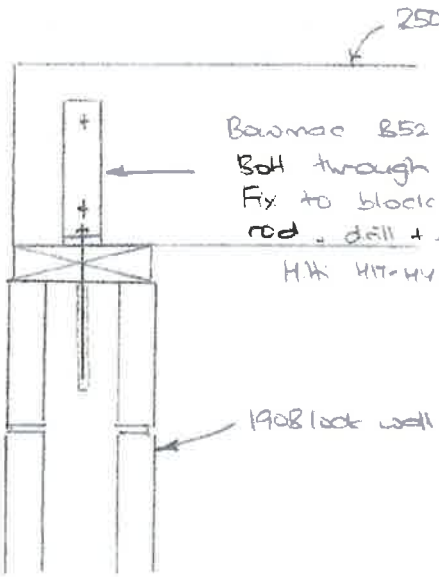
PLAN



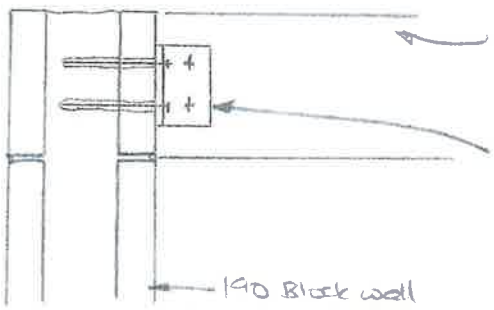
L-SHAPE CORNER TIE



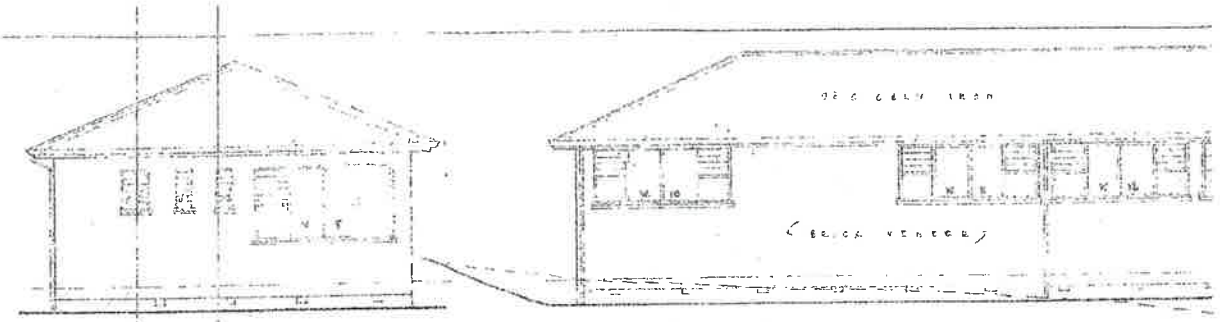
T-SHAPE CORNER TIE



FLOOR-WALL CONNECTION 01



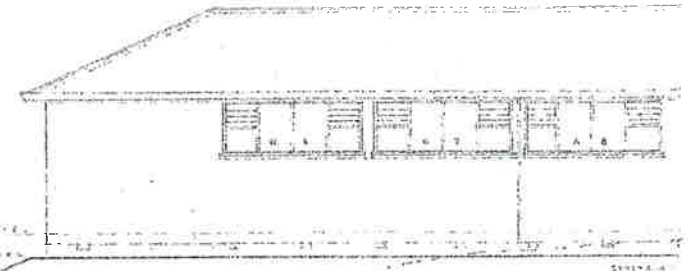
FLOOR-WALL CONNECTION 02



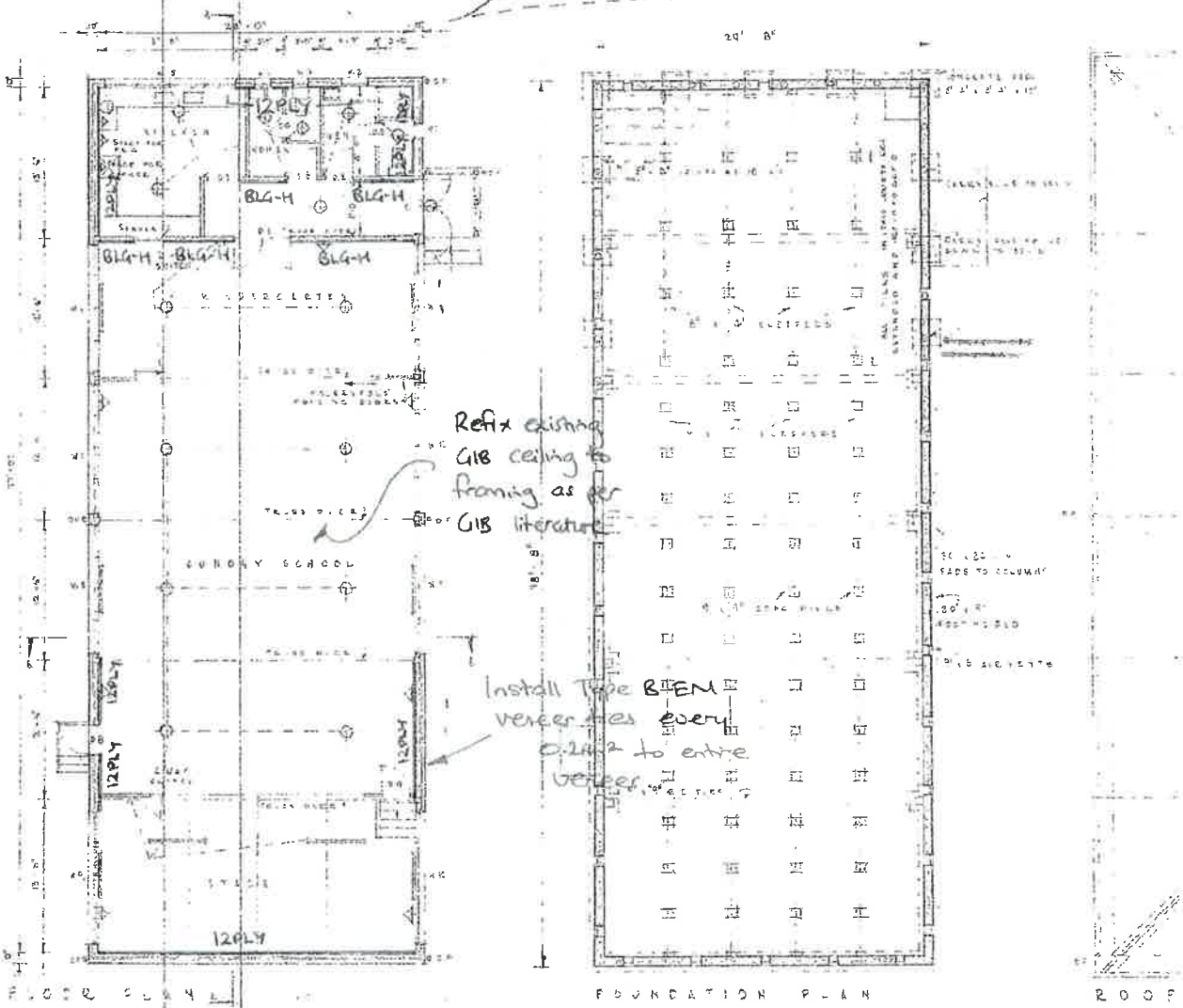
SOUTH - WEST ELEVATION

NORTH - WEST ELEVATION

NORTH - EAST ELEVATION



SOUTH - EAST ELEVATION



FLOOR PLAN

FOUNDATION PLAN

ROOF

NEW SUNDAY SCHOOL BUILDING - CHURCH OF THE MOST HOLY

STRENGTHENING TO 67% NBS

STRUCTEX - EA

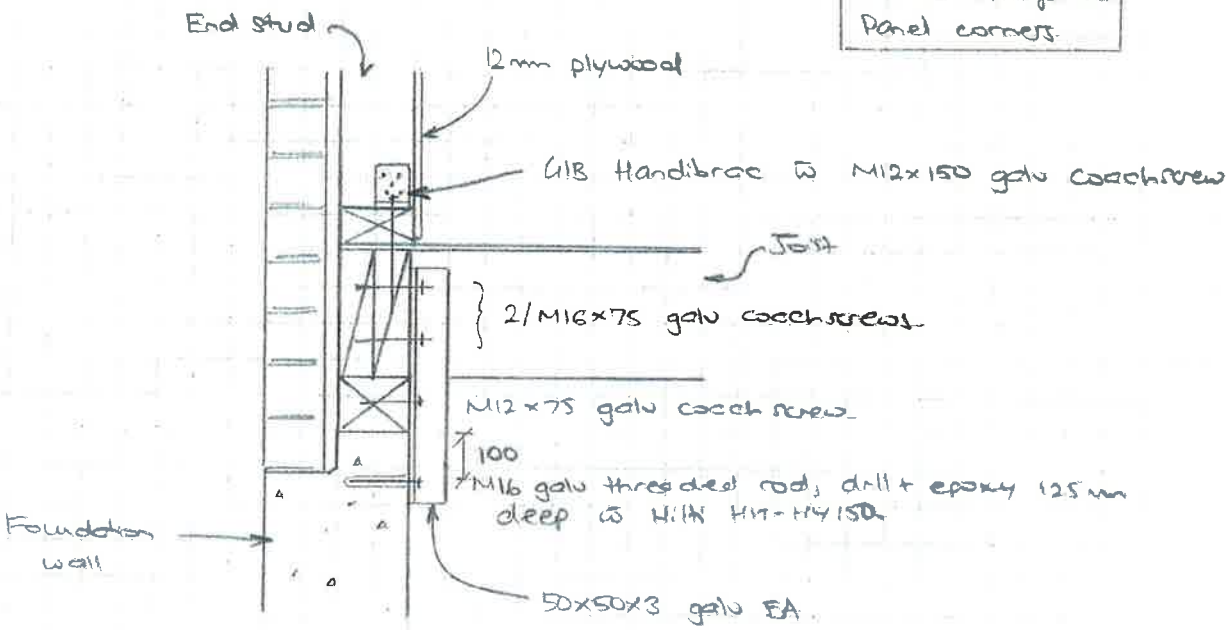
21/2/2012

SK-01

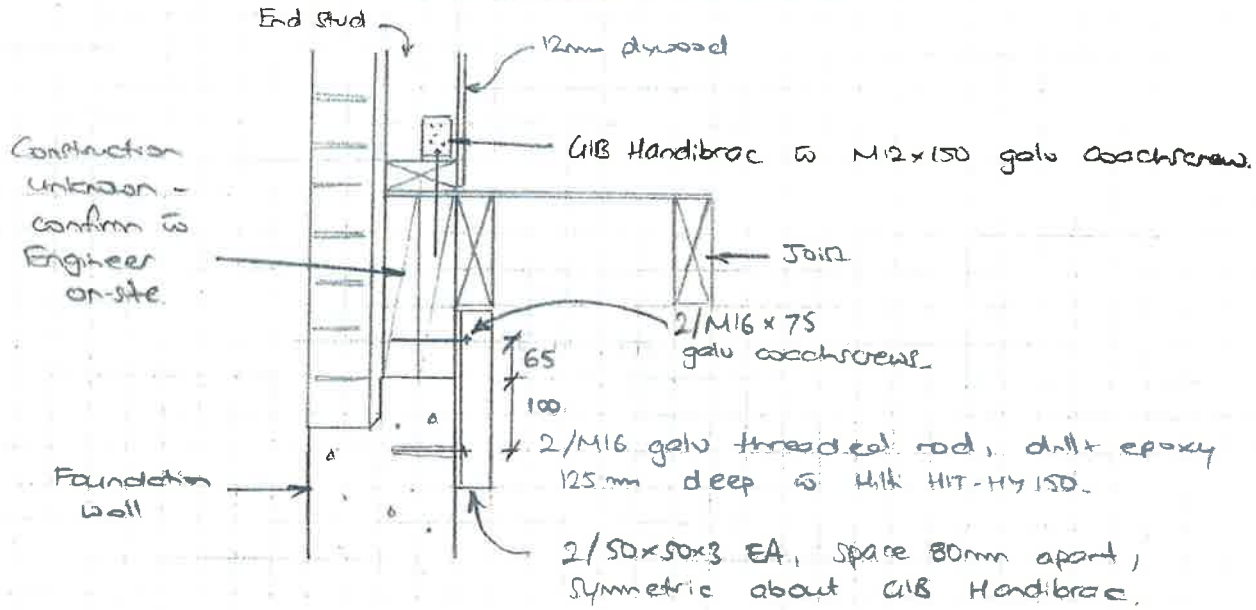
NOT TO SCALE

PANEL HOLDDOWN FIXINGS

Provide fixings at Panel corners.

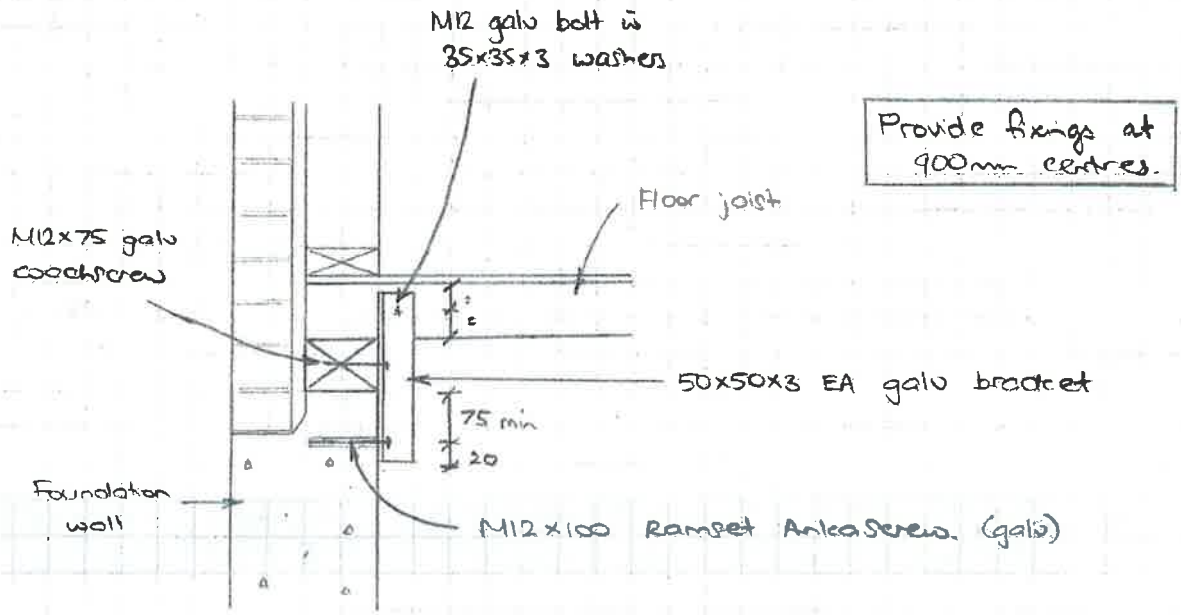


JOIST PERPENDICULAR TO WALL

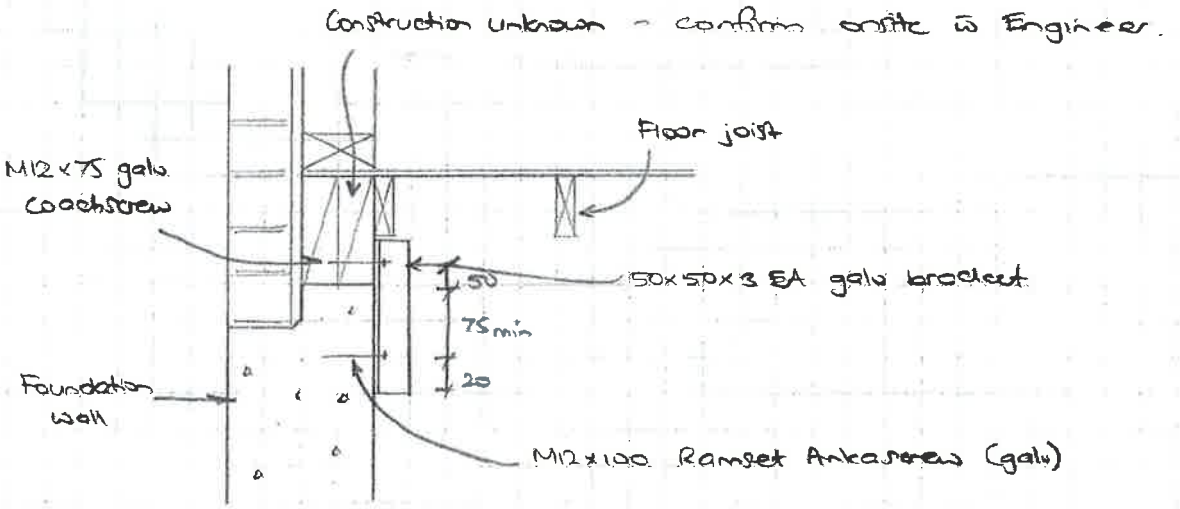


NOT TO SCALE

FLOOR - FOUNDATION WALL FIXING?



JOIST PERPENDICULAR TO WALL



JOIST PARALLEL TO WALL

Bottom Plate Fixing

MAY 2011

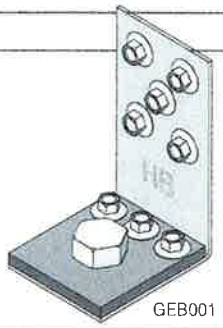
Bottom plate fixings for GIB® Bracing Elements			
Brace type	**Concrete slabs**		**Timber floors**
	External wall	**Internal wall**	**External and Internal walls**
GS1-N	As per NZS 3604:2011. No specific additional fastening required	As per NZS 3604:2011. Alternatively use 75 x 3.8 mm shot-fired fasteners with 16 mm washers, 150 mm and 300 mm from each end of the bracing element and at 600 mm thereafter.	Pairs of 100 x 3.75 mm flat head hand driven nails or 3 / 90 x 3.15 mm power driven nails at 600mm centres in accordance with NZS 3604:2011
GS2-N	Not applicable		
GSP-H BL1-H BLP-H	Intermediate fastenings to comply with NZS 3604:2011. In addition: GIB Handibrac® fixings or metal wrap-around strap fixings and bolt as illustrated on pages 19 and 20.		Pairs of 100 x 3.75 mm flat head hand driven nails or 3 / 90 x 3.15 mm power driven nails at 600 mm centres in accordance with NZS 3604:2011. In addition: GIB Handibrac® fixings or metal wrap-around strap fixings and bolt as illustrated below.
BLG-H	Not applicable	As for GSP-N, BL1-H, BLP-H on concrete slab above	

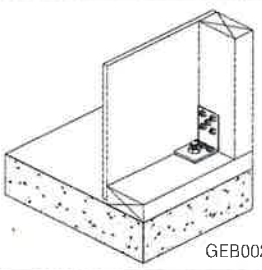
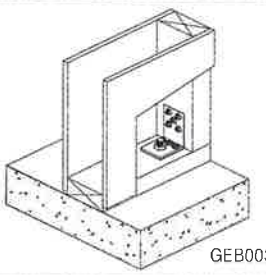
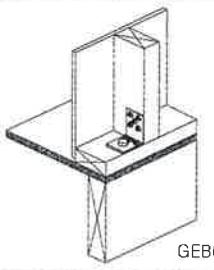
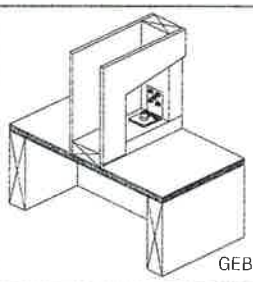
Panel Hold-down Details

GIB HandiBrac® – RECOMMENDED METHOD

Developed in conjunction with MiTek™ NZ, the GIB HandiBrac® has been designed and tested for use as a hold-down in GIB® BL, UL and GSP bracing elements.

- The GIB HandiBrac® registered design provides for quick and easy installation
- The GIB HandiBrac® provides a flush surface for the wall linings because it is fitted inside the framing. There is no need to check in the framing as recommended with conventional straps
- The GIB HandiBrac® is suitable for both new and retrofit construction
- The design also allows for installation and inspection at any stage prior to fitting internal linings


GEB001

Concrete Floor		**Timber Floor**	
External walls	**Internal walls**	**External walls**	**Internal walls**
 GEB002	 GEB003	 GEB004	 GEB005
Position GIB HandiBrac® as close as practicable to the internal edge of the bottom plate	Position GIB HandiBrac® at the stud / plate junction	Position GIB HandiBrac® in the centre of the perimeter joist or bearer	Position GIB HandiBrac® in the centre of floor joist or full depth solid block
Hold-down fastener requirements			
A mechanical fastening with a minimum characteristic uplift capacity of 15kN.		12x150mm galvanised coach screw	

Refer to gib.co.nz/cad for CAD details.