Canterbury Earthquakes Royal Commission

Komihana a te Karauna hei Tirotiro i ngā Whare i Horo i ngā Rūwhenua o Waitaha

3 October 2011

Gary Haverland
Senior Structural Engineer & Director
Structex Metro Ltd
PO Box 25-438
Victoria Street
CHRISTCHURCH 8014

Dear Mr Haverland

309 Durham Street North (Durham Street Methodist Church)
Information request

The Royal Commission of Inquiry into building failure caused by the Canterbury Earthquakes is currently inquiring into the failure of a number of buildings in the CBD, including the building that was situated at 309 Durham Street North, known as the Durham Street Methodist Church (the Building).

We have been provided with documentation by Tim Fahy of Arrow International in relation to the Building. This documentation includes the following in relation to Structex:

a) Structural Assessment Report dated 4 October 2010.

b) Copy of email from you to Judith Becker dated 21 October 2010.

c) Letter from you to Judith Becker dated 21 October 2010 re temporary propping.

d) Letter from you to Tim Fahy dated 1 February 2011 in relation to a further visit to the Building.

e) Letter from you to Tim Fahy dated 1 February 2011 in relation to an inspection of the Building on 19 January 2011 together with a sketch.

f) Structex Structural Assessment and Strengthening Report dated 17 February 2011 together with 3 drawings.

Would you please provide the following information, by **7 October 2011**:

1. Apart from the documentation which we already have as listed above, could you please provide copies of any further documentation you have in relation to inspections or assessments of the Building including photographs, drawings and calculations.

2. In reaching any of the conclusions in your reports in relation to the Building following inspections made by you, did you give consideration to any of the following matters:

   (i) The Building's plans.

   (ii) The construction history of the Building.

   (iii) The Christchurch City Council's earthquake prone policy and whether the Building complied with that.

   (iv) Any structural strengthening that had been carried out on the Building before the September earthquake.

   (v) The impact of the 4 September 2010 earthquake and subsequent aftershocks on the structural integrity of the Building and, in particular, whether the Building capacity to withstand further aftershocks was diminished as a result. If so, please explain how this was taken into account.

   (vi) Information from GNS or any other source about the likelihood, location or extent of further aftershocks. If so, please provide details of this information.

   (vii) The possibility of an aftershock approximately 1 magnitude less than the 4 September 2010 earthquake. If so, please provide details of what knowledge was known of this possibility and whether that was taken into account in carrying out the inspection/assessment.

   (viii) Information from the Christchurch City Council relating to building standards or the inspection of buildings following an earthquake. If so, please provide details of this information.

   (ix) Information from any other person or body relating to building standards or the inspection of buildings following an earthquake. If so, please provide details of this information.

The above information is requested pursuant to the Royal Commission's powers of investigation under s 4C Commissions of Inquiry Act 1908.

Yours faithfully

Mark Zarifeh
Counsel Assisting
Canterbury Earthquakes Royal Commission

structex

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13 October 2011

Mark Zarifeh
Canterbury Earthquakes Royal Commission
15 Barry Hogan Place
Addington
Christchurch

Dear Sir

Re: Response to request dated 3 October 2011 – 309 Durham St North

First please accept our apologies for the delay in getting this information to you. Your request for information did not arrive in our office until 12 October 2011, which is after your requested response date of 7 October 2011.

The following is our response to your letter dated 3 October 2011 regarding the above building with the references used corresponding to the references in your letter.

1. Please provide copies of any further documentation you have in relation to inspections or assessments of the Building including photographs, drawings and calculations.
    a. Copies of the following are included:
        i. 17 February 2011 – Methodist Church and Annex, Structural assessment and strengthening report.
        ii. 17 February 2011– Methodist Church Hall, Structural assessment and strengthening report.
        iii. 16 February 2011 – Letter to Arrow, Tim Fahy summarising report and request for advice on whether to proceed with temporary propping design.
        iv. 1 February 2011 – Letter to Arrow, Tim Fahy re site visit to view alternative egress routes for the removing of the organ.
        v. 1 February 2011 – Letter to Arrow, Tim Fahy re site visit to observe additional damage.
        vi. 17 November 2010 – Seismic inspection - Report 04.
        vii. 10 November 2010 – Letter to Arrow, Tim Fahy, re response to specific items pertaining to the Aldersgate buildingReport 03
        viii. 22 October 2010 – Seismic inspection - Report 02
        ix. 21 October 2010 – Letter to Arrow, Judith Becker, re review of temporary propping design.
        x. 4 October 2010 – Structural Assessment - Report 01.
        xi. 3 February 2011 – As built drawings prepared by Fulton Ross Team Architecture.
        xii. Calculations – suspect that these are of limited value as the supporting hand written calculations have been lost to water damage in our office following the February Earthquake.

xiii. Building levels.

xiv. Various photographs of the site.

2. In reaching any of the conclusions in your reports in relation to the Building following inspections made by you, did you give consideration to the following:

i. The Building Plans

a. Arrow International commissioned Fulton Ross Team Architecture to measure up and draw the existing building. Available in January 2011, these drawings comprised of site plans and elevations as opposed to detailed structural elements and connections, therefore were used primarily to assist in the calculation of seismic mass of the building and as a visual communication tool to convey to building stakeholders identified issues with the buildings.

b. The conclusions in the Structex Metro reports were largely based on observed building structural elements in the absence of such documented detail.

ii. The Construction History of the building

a. In October 2010 Structex Metro was engaged to identify and comment on earthquake damage to the building, possible strengthening options, and ultimately assess the building to determine if it is earthquake prone and in particular to outline repair requirements along with requirements to strengthen the building to 33% and 67% of the current code.

b. In preparing such assessments Structex Metro was required to and did give consideration to the construction of the building and compared that to current code.

iii. The CCC earthquake prone policy and whether the Building complied with that.

a. The assessment that the buildings were earthquake prone was tabled in the Structex Metro reports of 17 February 2011 with a number of aspects of the building assessed as earthquake prone. Prior to the completion of the analysis that supported these report findings it was not known how earthquake prone the building was. The reports outlined the repairs required to reinstate the building to its pre-earthquake condition, as well as strengthening work required to achieve a seismic strength of 33% of current code and additional work required to achieve 67% of current code.

b. Structex Metro carried out a seismic assessment of the building using AS/NZS 1170.5 to determine applied loadings to the buildings. The NZ Society of Earthquake Engineering Guidelines, (June 2006) was also used to assess the building capacity. In preparing the reports for the Church and the Hall consideration was given to the assessed importance level of the buildings as outlined in the CCC earthquake prone policy. Structex Metro assessed:

i. The church as an Importance level 3: refer Methodist Church and Annex, Structural assessment and strengthening report dated 17 February 2011;and

ii. The Hall as an Importance level 2 (normal): refer Methodist Church Hall, Structural assessment and strengthening report dated 17 February 2011.

iv. Any structural strengthening that had been carried out on the Building before the September earthquake.

a. There did not appear to be any structural strengthening carried out to the building prior to September 2010. Some Rosehead washers were present in various locations. It is not known when these were installed only to say that they appear to have been in place for some time.

b. The lack of any significant strengthening meant that the structural strengthening was not taken into consideration when presenting conclusions on this building.

v. The impact of the 4 September earthquake and subsequent aftershocks on the structural integrity of the building and in particular, whether the buildings capacity to withstand further aftershocks was diminished as a result. If so please explain how this was taken into account.

a. Structex Metro did consider the impact of the 4 September earthquake and subsequent aftershocks. That is clear from the October 2010 report through to the February 2011 reports. The 4 September earthquake and subsequent aftershocks did, therefore, influence the conclusions tabled in the Structex Metro reports.

b. In its report of 4 October 2011 Structex Metro concluded that the earthquake on 4 September had reduced the seismic capacity of the building as was evidenced by the extent of the damage and cracks that had formed, and Structex Metro also noted that ongoing aftershocks continued to cause further deterioration.

c. Structex Metro responded to requests between October 2010 and February 2011 from the Arrow International Project Manager to inspect the building on a number of occasions to discuss the ongoing deterioration of the building.

d. Based on its report of 4 October 2010 Structex Metro concluded that parts of the hall had suffered significant damage, the west end annex of the auditorium had suffered limited damage, the auditorium towers at the east end, including the east wall had suffered significant damage, the side walls of the auditorium were in relatively good condition. Overall the structural elements in the auditorium were still in place and the building did not appear unstable however the seismic capacity of the building had been reduced.

e. Temporary propping was reviewed by Structex Metro in October 2010: refer our letter dated 21 October 2010 to Arrow International Limited. Structex Metro advised that based on our inspection and report dated 4 October 2010 we considered that while the east wall and north east tower east end of the building had suffered significant damage and were being propped, the main Church auditorium had not had significant structural damage and is therefore unlikely to collapse as a result of significant aftershocks.

f. In the Seismic Inspection - Report 02 dated 22 October 2010 Structex Metro considered the building's ability to withstand further aftershocks, in particular in relation to the east wall and north-east tower.

g. The damage caused by subsequent aftershocks and the likelihood of further aftershocks was also a consideration when commenting on an alternative egress from the building and the safety precautions required to be exercised by those working in the building to extract historically significant items: refer Structex Metro's letters dated 10 November 2010, 1 February 2011 (2) and 16 February 2011 to Arrow International Limited.

vi. Information from GNS or any other source about the likelihood, location and extent of the further aftershocks. If so, please provide details of this information.

a. No recollection of such information being available.

vii. The possibility of an aftershock approximately 1 magnitude less than the 4 September 2010 earthquake. If so please provide details of what knowledge was known of this possibility and whether that was taken into account in carrying out the inspection/assessment.

a. No specific assessment was done for the building to withstand an aftershock of one magnitude less than the 4 September earthquake.

b. Typically as engineers, designs are not developed for magnitude but rather for ground accelerations as per the industry standards. As stated above, Structex Metro carried out a seismic assessment of the building using AS/NZS 1170.5 to determine applied loadings to the buildings. The NZ Society of Earthquake Engineering Guidelines, (June 2006) was also used to assess the building capacity.

viii. Information from Christchurch City Council (CCC) relating to building standards or the inspection of buildings following an earthquake. If so, please provide details of this information.

a. Mr. Haverland aided Civil Defence and CCC on a number of occasions and therefore attended briefings prior to undertaking Building Safety Evaluations.

b. Structex Metro also referred to the Building Act 2004 as well as regulations relating to dangerous, earthquake prone or unsanitary buildings. Structex Metro also used AS/NZS 1170.5 to determine applied loadings to the buildings and referenced the NZ Society of Earthquake Engineering Guidelines, (June 2006).

ix. Any information from any other person or body relating to building standards or the inspection of buildings following an earthquake. If so, please provide details of this information.

i. No other information was referenced.

Yours sincerely

Structex Metro Ltd

Justin Davies

Chief Executive

Enc: Items listed in report 1a) above.

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10 November 2010

Tim Fahy
Arrow International Ltd
PO Box 42
Christchurch 8140

Dear Tim

Re: Methodist Church Aldersgate Building, Durham Street, Christchurch

We have been asked to comment on a number of items relating to the Aldersgate building in Durham Street for the Methodist Church, and refer to the "Brief to Structex" that was emailed to us on 1 November 2010.

The four specific items are as follows:

1. Advise on Options for Protecting the Existing Entry Atrium

The existing glass atrium on the north side of the Aldersgate building serves as the main entry and is located immediately adjacent to the Durham Street Methodist church which has been significantly damaged by the earthquake on 4 September 2010. The towers and east wall of the church building have had loose stone removed, securing straps installed and steel braced frames are currently being installed to provide stability to the east wall and north-east tower.

The atrium itself is structurally sound and has not suffered any visible structural or non-structural damage.

In order to protect people using the entry and atrium from possible falling stone work a timber frame and plywood tunnel has been proposed inside the atrium. While this is an option for personal protection its construction would need to be robust to prevent stones from puncturing the roof after falling from height.

A tunnel inside the atrium will not prevent damage to the atrium itself.

An alternative option would be to construct a scaffold wall adjacent to the atrium, lined with steel mesh. Timber planks should be provided at high level, just below the areas of loose stonework at the adjacent church. This option has the advantage of maintaining natural light and space to the entry and allows any falling stones to be caught by the scaffold planks at high level, before falling too far. It also provides property protection to the existing glass atrium. This scaffold wall could remain in place while the adjacent church is repaired or demolished.

2. Confirm Safe Occupancy to Aldersgate

On 1 November 2010, a walkover survey through the interior and exterior of the Aldersgate building was carried out by Tim Fahy and Gary Haverland.

The building was observed to be in sound condition and is safe to occupy for normal use, provided the entry atrium area is protected by scaffold as outlined above.

Minor, non-structural damage was observed in some areas. However, this is superficial only. We would recommend that:

(a) Dislodged ceiling tiles be placed back neatly.

(b) Flaking paint around superficial cracking be tidied up and re-painted.

(c) Floors be vacuumed and sills wiped to clean away any fallen debris and provide a tidy appearance.

(d) There appears to be some difference in the floor level in the corridors at first floor level adjacent to the Durham Street extension. It is likely that an infill section adjacent to a seismic joint has been dislodged. The carpet should be neatly cut away and lifted in this area to allow the substrate to be reinstated and the floor coverings put neatly back in place. If anything unusual is found, please notify Structex to allow an inspection to be carried out.

Please note that all these items of repair are cosmetic only and are required to assist in staff perception of a safe environment.

3. Use of Accessible Toilet Facility

The accessible toilet is currently located below the mezzanine floor in the annex at the west end of the main church building. This area of the annex is in relatively good condition with very little visible damage in the ground floor area.

The existing accessible toilet can be re-used. As a precaution, 17.5mm plywood should be placed on the mezzanine floor over the toilet and its access path. This will provide additional protection if in the unlikely event that stones are dislodged from the upper level walls.

Access doors from the toilet area into the hall and adjacent areas should be blocked off or locked to prevent people walking into areas that are not positively protected.

4. Relocation of the Main Entry

The existing entry is located on the north-east corner of the Aldersgate building. Although this existing entry could be safely maintained with the installation of protective scaffolding and alternative entry could be placed anywhere between columns along the east wall facing Durham Street. The infill sections of wall between columns appears to be non-structural and can be cut out. Please note that the height difference would require steps and an access ramp to be installed, which would extend a new entry some distance into the building.

If you have any questions, please feel free to contact me.

Yours sincerely
Structex Metro Ltd

Gary Haverland B.Eng (Hons)(Civil)
Senior Structural Engineer &
Director
MIPENZ CPEng # 209540

structex

Project 10499/5 – 4 October 2010

Methodist Church
Durham Street, Christchurch
Structural Assessment Report

for

Arrow International Ltd

Contents

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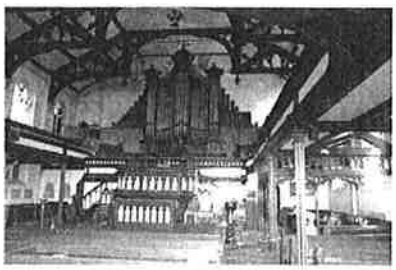
4 October 2010

Judith Becker
Arrow International Ltd
PO Box 42
Christchurch 8140

Dear Judith

Re: Methodist Church, Durham Street, Christchurch - Structural Assessment Report


Introduction

Structex Metro Limited has been engaged to complete a structural assessment report of the Methodist Church in Durham Street, Christchurch.

The purpose of this assessment is to identify and comment on earthquake damage to the building, and possible strengthening options.

Limitations of Report

Findings presented as part of this report are for the sole use of Arrow International Ltd and their client, the Methodist Church. 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.

The structural assessment comprises a walkover survey of the property and does not include a detailed review of drawings or a detailed inspection/investigation of structure that is hidden behind or beneath wall, ceiling and floor finishes. A search of Christchurch city Council records has *not* been undertaken. The assessment provides a structural overview of the main structural elements that are visible, as well as comments on issues associated with the foundations and soil conditions. Strengthening options are based on experience and judgement only, and detailed calculations have not been carried out as part of this assessment.

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

A summary of the structural assessment is as follows:

(a) The Hall has suffered significant damage as a result of the recent earthquake on 4 September 2010. Extensive reconstruction to a significant portion of the hall will be required, if this part of the building is to be retained.

(b) The Annex has suffered limited damage, mainly to the west wall. This part of the building could be retained with moderate repair work and some additional work to strengthen to 67% of current code.

(c) The Church auditorium has had significant damage at the east end and will require reconstruction of the towers and east wall. It is expected that the remainder of the building can be retained, repaired and strengthened up to 67% of current code.

Building Location & Description

The Church is located in Durham Street, in the Central Business District of Christchurch city and was constructed in 1864.

The complex consists of three main areas, the main Church auditorium, the Annex located at the western end of the auditorium and the Hall located in the south west corner of the site.

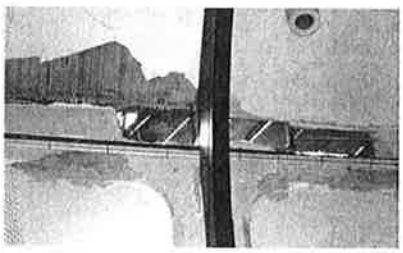
The buildings are generally constructed with stone walls, consisting of a natural stone exterior, a plaster brick and stone interior and a combination of rubble and stone fill to the cavity.

The slate roof is likely to be supported on battens with timber sarking on purlins and main supporting exposed timber trusses. A ceiling is constructed with lathe and plaster. The ground floor is timber and is likely to consist of timber flooring boards on joists supported on timber bearers on concrete or timber piles.

A gallery floor has been constructed in the auditorium which extends around the perimeter of this area. Access to the gallery is by two stairs at the front of the church facing Durham Street which incorporate two stone towers.

The building has been damaged by the recent 7.1 magnitude earthquake on 4 September which was located about 30km from Christchurch. Ongoing aftershocks continue to cause further damage.

Hall east wall damage



damage at truss locations in Hall

Hall Assessment

The hall measures around 20 x 11m in plan.

Significant damage has occurred to the upper section of the east wall where part of this wall at roof level has collapsed out.

The ceilings in this area have also been damaged, with damage ranging from cracked lathe and plaster to partial collapse.

Damage has also occurred between the timber roof truss and the side walls with varying degrees of cracking, including spalling of the stone around the truss support.

west wall of Hall leans out

The western side of the Hall wall has two continuous, almost full length horizontal cracks, one located about 1200mm from the floor and the other located near the top of the wall. The wall is leaning out significantly between these two cracks. It is estimated that the wall has an outward lean of about 200-250mm.

The lathe and plaster ceiling is cracked, primarily at the cove lines and at the junction to the stone walls, where significant damage has occurred.

A number of cracks are present in the infill stone walls between the side wall columns.

A crack has occurred in the wall in the south west corner where the gable and side wall have started to separate.

Cracks to the infill stone walls in Hall

The mortar used to construct the hall is a weak lime mortar and can be easily scraped away with a metal object.

The hall is significantly damaged from the earthquake and will require reconstruction of the entire west wall, reconstruction of the upper section of the east wall, reconstruction of the junctions between the trusses and east side wall, and repairs to the ceiling. Some areas of the ceiling will require replacement.

In addition to this an earthquake assessment will be required and strengthening to 67% of current code is likely. This will require additional structural work.

Annex Assessment

The Annex measures approximately 18 x 8m in plan and is located on the west side of the main Auditorium. It includes a timber first floor with offices located below on a timber ground floor.

The roof is generally clad with slate tiles to the perimeter with a flatter metal roof to the central area that adjoins the west wall of the Auditorium.

A panelled ceiling prevented viewing the roof structure and did not show signs of significant cracking, however the nature of this ceiling will assist in concealing cracks.

Annex west wall displaced from Truss

Minor cracking was observed in the east wall, which is a common wall with the west end of the Auditorium.

The west wall of the annex has displaced from the roof trusses as well as from the north gable wall and has formed a crack in the north west corner near the ceiling level.

The ground floor walls to the annex were viewed and had only a few minor cracks. Very little damage was visible in this area.

The main area of damage to the annex appears to be on the west wall where the top of the wall has displaced from the roof structure and at the north wall junction.

Crack formed in north wall corner of Annex

The displacement does not appear to be excessive and could be repaired by grouting up the existing cracks and re-fixing the roof structure to the western exterior wall.

Additional work required to strengthen this building to 67% code is likely to include the following:

(a) Tie external walls to first floor structure.

(b) Tie gable and side walls to roof structure.

(c) Possible roof bracing installation.

damage to auditorium stair walls, east end

Auditorium Assessment

The auditorium measures approximately 28 x 18m in plan. The main area of damage has occurred in the eastern towers where the stairs are located. Significant damage has occurred in this area with cracks clearly visible on the exterior face, generally in the stone mortar joints. The plaster has spalled significantly on the interior face with significant damage visible to the brick interior face and to the core of the wall.

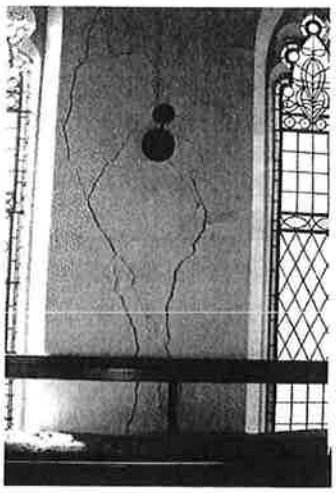
Significant cracking has occurred to the eastern wall of the auditorium facing Durham Street.

Stone work around the window frames has dislodged and damage has occurred primarily at the mortar joints. The leadlight glazing appears to have suffered little damage.

The side walls to the auditorium are still in relatively good condition with some cracking on the inside plaster face above the windows.

The buttresses to the outside side walls are generally cracked along the mortar joints between the stone.

The towers facing Durham Street are significantly and extensively cracked.



east wall damage

Some spalling of stone work has occurred where the timber gallery beams are housed into the stone walls.

The timber ground floor appears to have bulged in the middle and could be the result of some foundation settlement below the exterior heavy stone walls, or heaving of the light timber floor, or a combination of both. This has also resulted in some displacement and residual lean of the southern timber posts support the gallery floor.

The lathe and plaster ceiling is also significantly cracked through the entire ceiling.

Cracked ceiling in auditorium

In our opinion the Auditorium could be retained with the following work likely to be required:

(a) Remove the towers and east wall of the auditorium and retain all stone work. Reconstruct the towers and east wall in reinforced concrete and place stone on the exterior face to retain the same visual appearance both internally and externally.

Cracks to mortar joints in Auditorium buttresses

Side walls of Auditorium in good condition with some cracking above windows

Spalling of stone around gallery beams in Auditorium

(b) Inject cracks to the side walls and buttresses with grout injection to re-establish strength.

(c) Secure roof trusses into side walls at buttress locations.

(d) Possibly install concrete insitu column within the side wall buttresses, and flush with inside face to enhance side wall strength to 67% code.

(e) Remove lathe and plaster ceiling and reline with bracing installed behind ceiling to enhance strength to 67% code.

(f) Tie end wall west gable, and new east wall gable into roof structure.

(g) Remove loose stonework around side wall windows and re-fix in place with steel pins or grouted joints to enhance strength.

(h) Re-fix gallery beams and associated spalled stone work in place.

(i) Re-level ground floor and realign posts supporting gallery floor.

It is possible some foundation enhancement work may be required, depending on the existing ground conditions. Further detailed geotechnical information will be required.

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

Yours sincerely
Structex Metro Limited

Gary Haverland B.Eng (Hons)(Civil)
Senior Structural Engineer &
Director
MIPENZ CPEng # 209540

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1 February 2011

Tim Fahy
Arrow International Ltd
PO Box 42
Christchurch 8011

By Email: tim.fahy@arrowinternational.co.nz

Dear Tim

Re: Methodist Church Durham Street, Christchurch

As requested we have carried out a further visit to the Methodist Church at Durham Street, Christchurch with yourself to view alternative egress routes for removing the organ and other chattels.

The current designated safe path from the Church building is through the protected Aldersgate entry.

In order to reduce the disruption in this area we reviewed the possibility of providing access through the north door of the annex. If access is to be provided through this area protective scaffold will be required over the door. This is necessary to provide protection against loose stonework being dislodged from the top of this wall. The scaffold and protective planks should be as high as possible to reduce the impact loading from falling stones.

A number of large pinnacle stones, which are loose, are present on the adjacent buttress. These will also need to be removed.

Also, in order to reduce disruption to the rear carpark, contractors trucks could be parked adjacent to the west wall of the hall. Although this wall is on an outward lean of about 80mm, roof ties are present to provide some stability to the wall. Parking in this area should be kept to a minimum in order to reduce the risk.

Contractors will need to be advised of the risk and evacuate the area immediately if there is a noticeable aftershock.

If you have any questions, please feel free to contact me.

Yours sincerely
Structex Metro Ltd

Gary Haverland B.Eng (Hons)(Civil)
Senior Structural Engineer &
Director
MIPENZ CPEng # 209540

ACENZ

seismic inspection report 02 **Date:** 22 October 2010 structex

Project:	Methodist Church – Durham Street 309 Durham Street, Christchurch	**By:**	Gary Haverland	**Ref:**	10499/5
Distribution	Colin Messent, Arrow International (colin.messent@arrowinternational.co.nz Judith Becker, Arrow International (Judith.becker@arrowinternational.co.nz)				

A visit to the Durham Street Methodist Church was carried out on 22 October 2010 with Colin Messent of Arrow International and Ben West, the stone mason.

Some concern was expressed by Ben West at the lack of propping that had been put in place to provide temporary securing.

A temporary propping design has been carried out by RD Sullivan and fabrication is underway. It is likely to be installed in the next 2-3 weeks.

Currently the footpath area has been closed off on the east and north side of the Church. Loose stones and parapet have already been removed from the towers and east wall.

Straps have been wrapped around the top of the towers to secure the top portions of the tower.

There are some significant vertical cracks to the north-east corner of the north-east tower. Some bulging at the mid height of the tower is also occurring as evidence of instability.

After viewing the east wall and towers it was considered that:

(a) A very significant aftershock would be required to cause instability and possible collapse of the east wall and north-east tower.

(b) If the north-east tower did collapse it would fall down, within its own general proximity, rather than falling out onto the street.

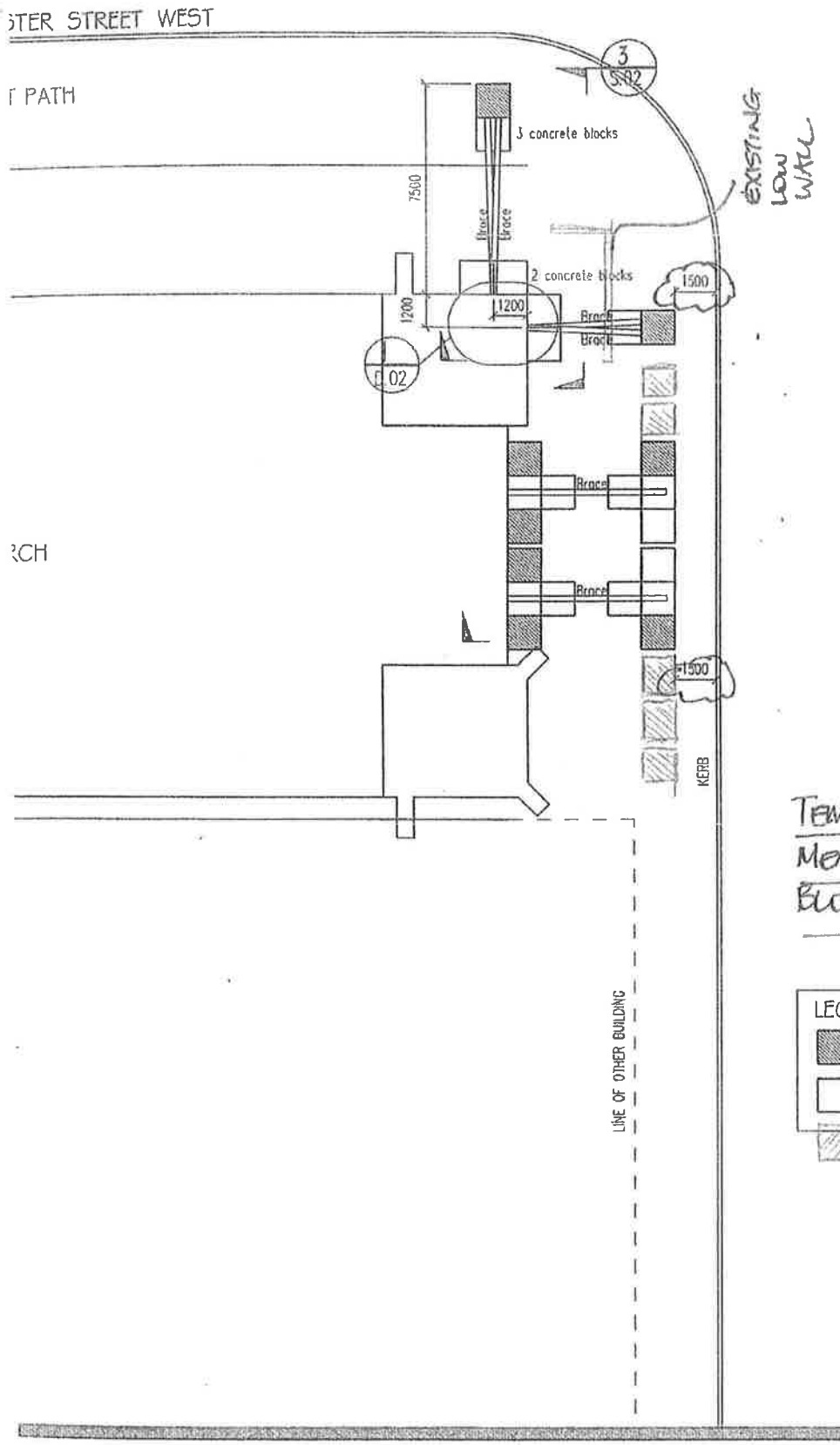
(c) The north-east tower is bounded by a stone wall and metal fence, and falling stone is unlikely to fall outside the fence line.

(d) As the east wall is partially restrained by the inside gallery floor, collapse of the entire wall is unlikely, and the top portion is most likely to fall well within the entrance courtyard, away from the footpath and current pedestrian area.

(e) The south-east tower has some cracking, however, the corner buttresses assist in providing stability.

(f) A prudent precaution to provide additional protection to pedestrians is to install a line of concrete blocks as shown on the attached sketch. These blocks are expected to be installed on Saturday 23 October 2010, and will be used for the temporary bracing when it is installed.

Gary Haverland B.Eng (Hons)(Civil)
Senior Structural Engineer &
Director
MIPENZ CPEng # 209540



SITE PLAN

ODIST CHURCH

ST WEST, CHRISTCHURCH

Design	RDS
Drawn	SN/TT
Date	18.10.10
Scale	1:200@ A3

Job No. 5123.003
Sheet No. SP.01/A
19-10-10

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16 February 2011

Tim Fahy
Arrow International Ltd
PO Box 42
Christchurch 8140

Dear Tim

Re: Durham Street Methodist Church

As requested, Structex have now completed the seismic assessment of the Durham Street Methodist Church Hall and Auditorium.

The seismic assessment shows that the areas of the building having the highest risk of earthquake damage are the side walls and towers, in both the longitudinal and transverse directions (along and across the building). This is evidenced by the extent of damage in these areas as a result of the Darfield Earthquake in September 2010.

The weakest area of the building is the Auditorium of the main church which has a transverse lateral load capacity of 10% of current code. This assessment and strength is based on the building in its pre-earthquake condition, with no cracks. The building in its current state will have a strength less than its assessed value.

Following our recent visits to the building, which have been carried out after the Boxing Day earthquakes, there has been noticeable additional damage, particularly to the north wall annex. Cracking of the side wall buttresses also appear to have increased.

Further damage will continue to occur as a result of on-going aftershocks, which could result in the building becoming unsafe.

We understand that the building, as well as its contents are of significant historical value. It is therefore necessary that additional temporary bracing be installed to the north wall of the Auditorium, as well as the west well of the Hall to provide longer term protection to the building and its contents in the event of significant on-going aftershocks.

If repaired, the proposed repairs and strengthening work to the Church and Auditorium is extremely invasive work requiring significant heavy structural work. Fittings and fixtures will therefore require removal prior to repair and strengthening work being carried out.

Please advise us if you require us to proceed with the design of temporary bracing to these areas.

If you have any questions, please feel free to contact me.

Yours sincerely
Structex Metro Ltd

Gary Haverland B.Eng (Hons)(Civil)
Senior Structural Engineer &
Director
MIPENZ CPEng # 209540

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21 October 2010

Judith Becker
Arrow International Ltd
PO Box 42
Christchurch 8140

Dear Judith

Re: Methodist Church Durham Street – Temporary Propping

Thank you for forwarding to us the proposed temporary propping details for Durham Street Methodist church (SP 01A, S.01A, S.02, S.03, D.01, D.03 and one unlabelled sheet), designed by RD Sullivan, consulting engineer.

We understand you have contacted Dick Sullivan who has prepared these drawings to advise him that Structex are carrying out a review.

Our review consists of a brief overview of the drawings to provide a second opinion on how appropriate the proposed propping is, and does not include design calculations.

We also understand that the intention of the propping is to provide public safety and avoid collapse of the towers into the footpath.

We understand that the propping to the hall will not be installed and therefore we have not reviewed these details.

The proposed propping system and details appear to be of a robust nature to provide temporary medium term support to the east wall and north-east tower.

We understand the hole to the existing masonry wall for the RB20 Reid bar will be core drilled with a diamond drill from the outside face. We believe this is the most appropriate method to reduce vibration to the stone during drilling, with a very low risk of significant spalling to the inside face of the stone as the hole is created.

We would suggest that a 300 x 100 timber packer, 600mm long, with a 100 x 10 square washer be used on the inside face in lieu of the proposed 600 x 600 x 12mm plate. The timber packers are significantly lighter and would ease installation. Please refer to the marked up sketch attached.

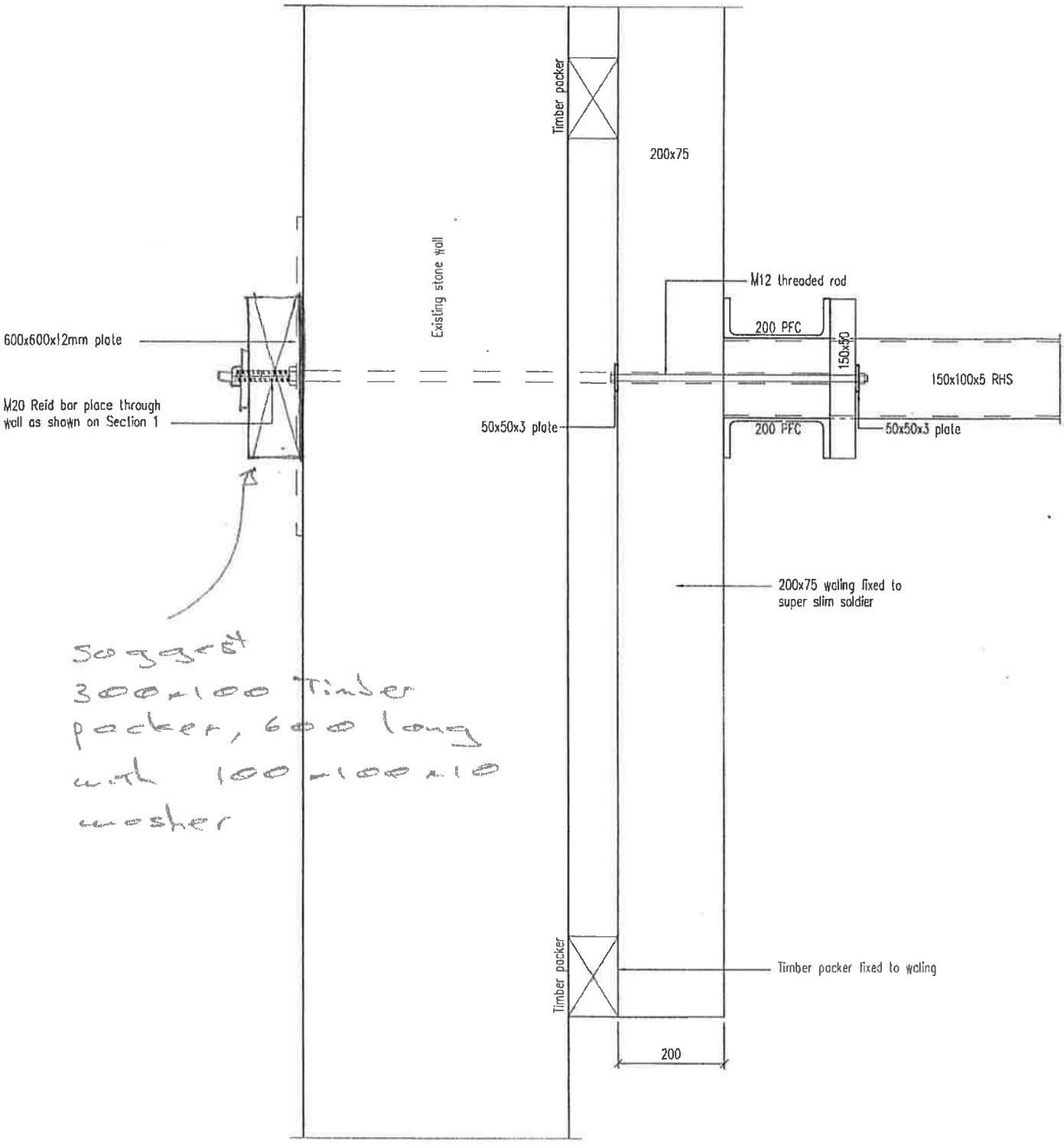
Based on our inspection and report dated 4 October 2010, we believe that the main Church auditorium has not had significant structural damage and is therefore unlikely to collapse as a result of significant aftershocks. Temporary propping in addition to the tower is not considered to be necessary to allow removal of the organ, piano and music library. We recommend that

building occupancy be minimised to assist in reducing risks to persons carrying out the removal work.

If you have any questions, please feel free to contact me.

Yours sincerely
Structex Metro Ltd

Gary Haverland B.Eng (Hons)(Civil)
Senior Structural Engineer &
Director
MIPENZ CPEng # 209540



PLAN (1/S.01) Scale 1:10

R.D. SULLIVAN
CONSULTING ENGINEER
P.O. Box 21-185 Edgeware
Ph 365-3644 Fax 365-5096 ChCh
Email rdsull@xtra.co.nz

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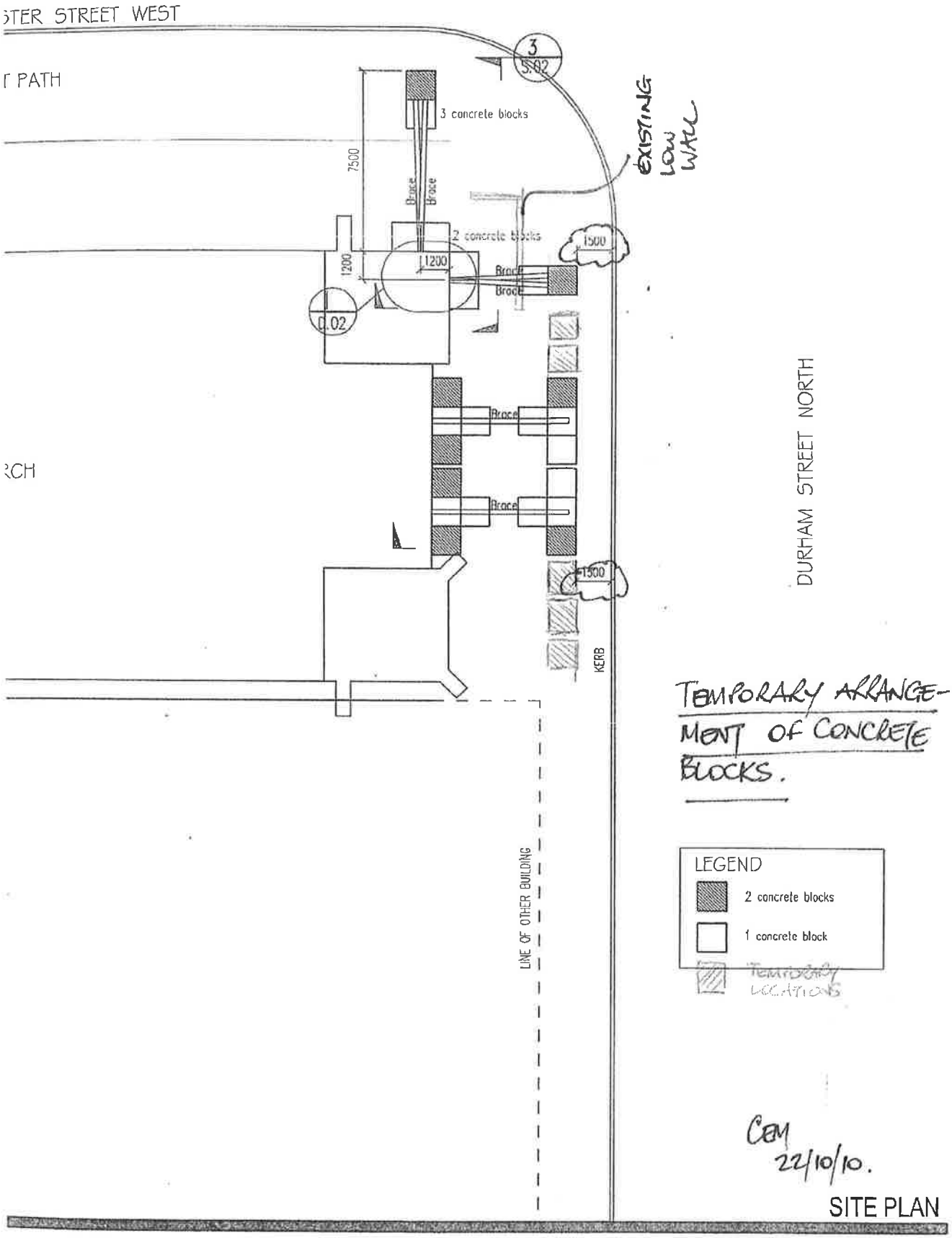

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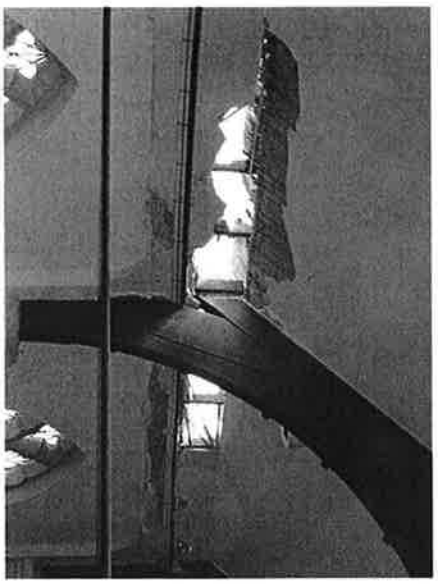
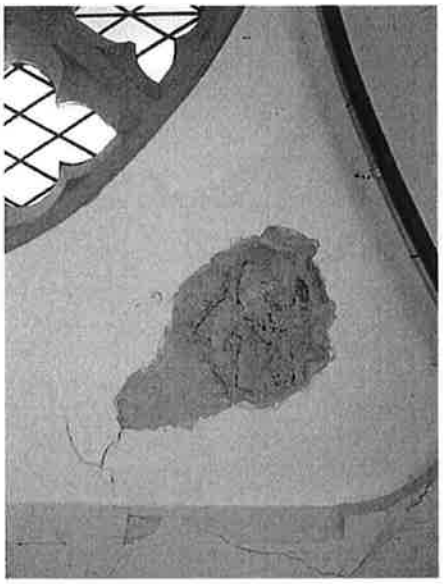
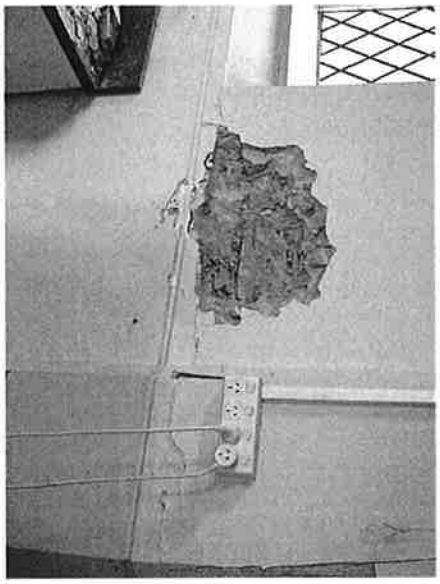



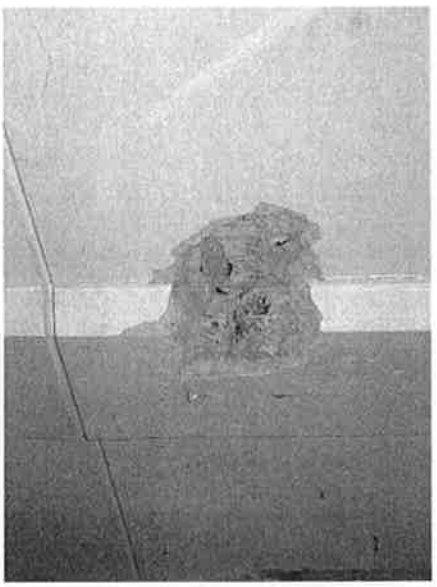


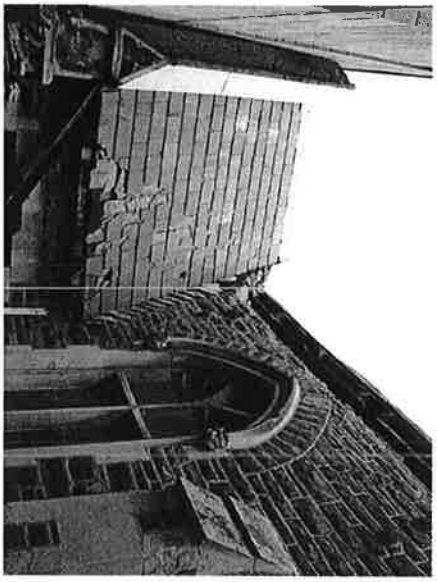

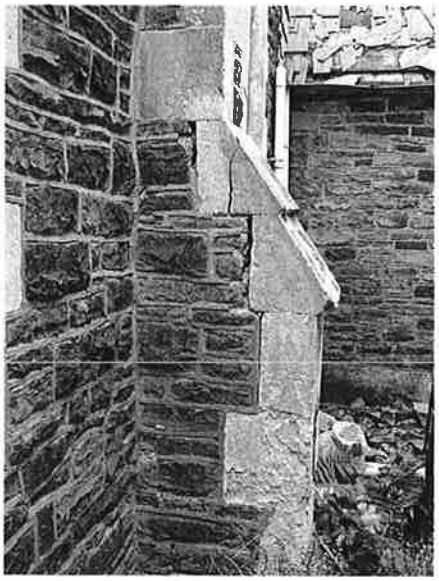



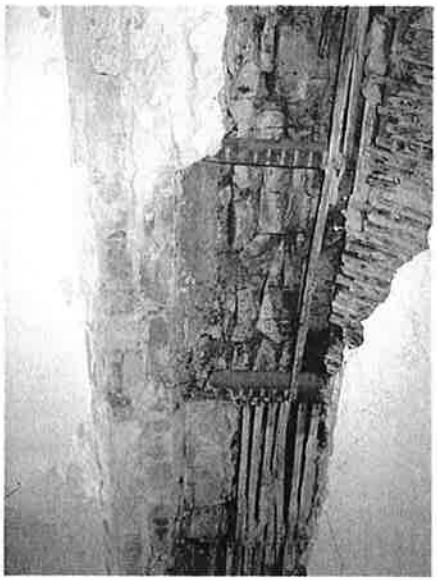


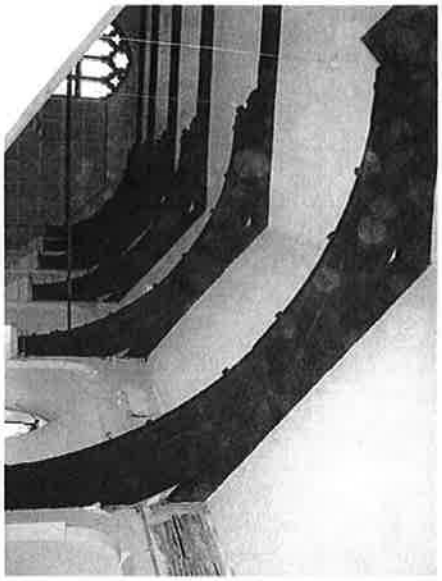
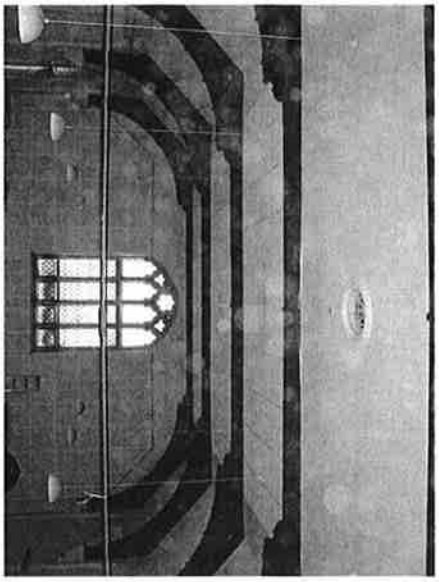
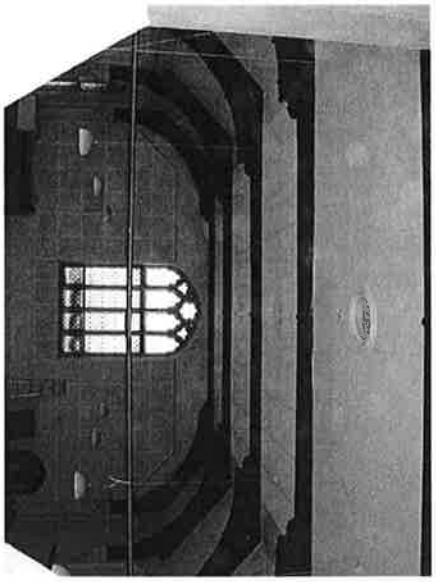
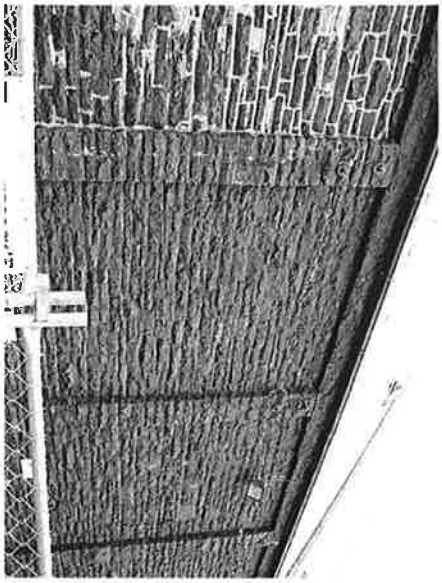


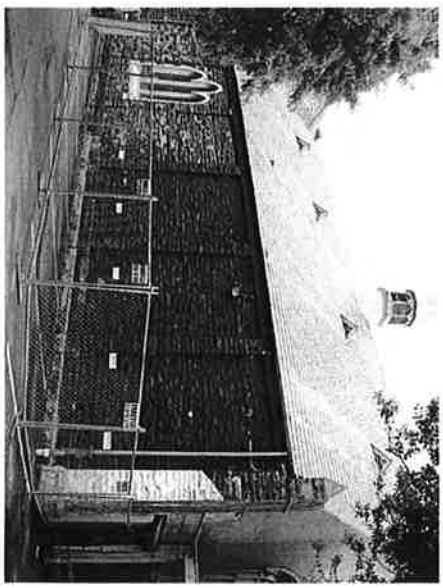
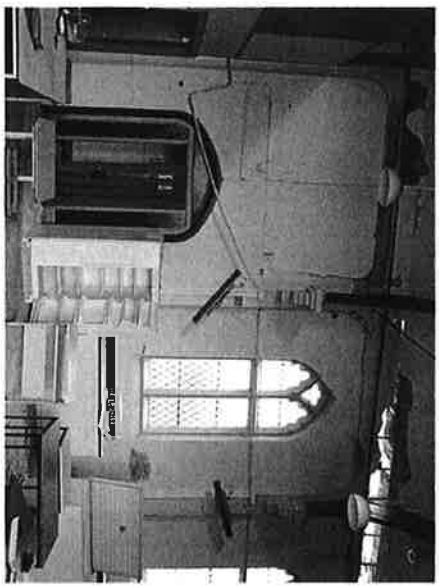


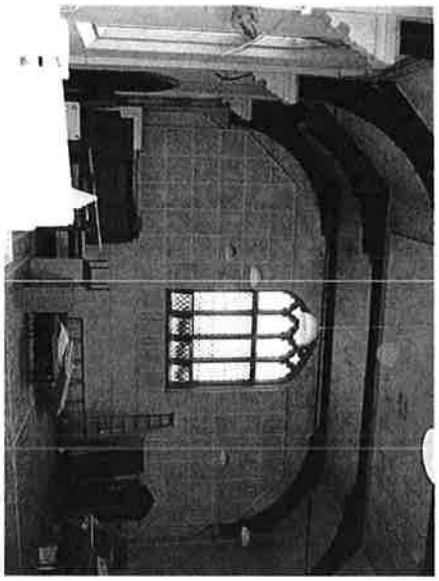

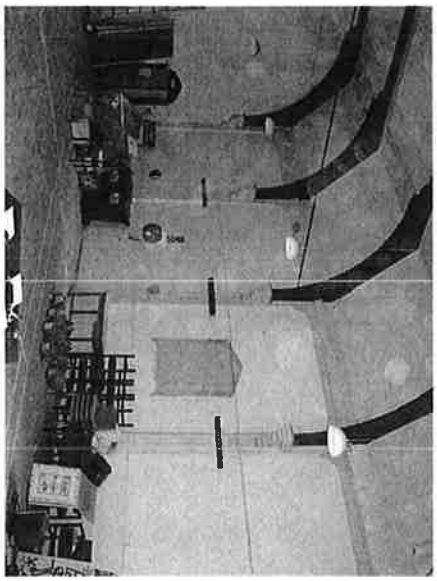

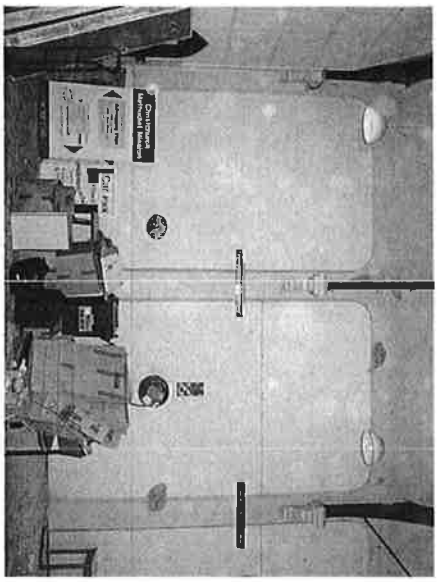

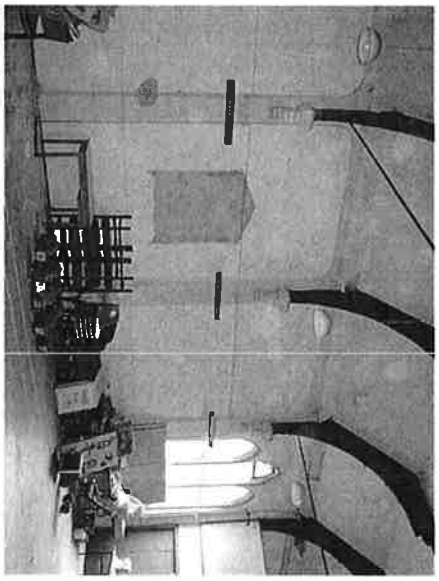

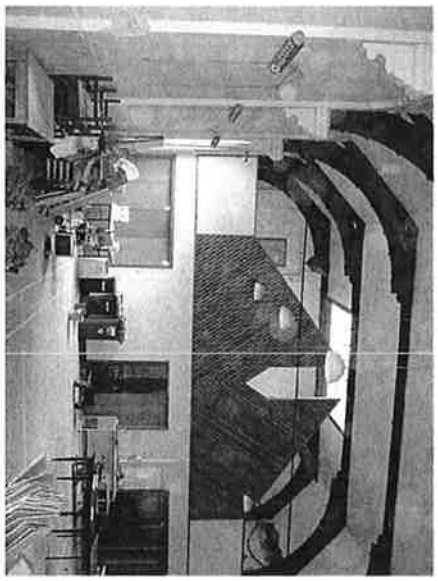

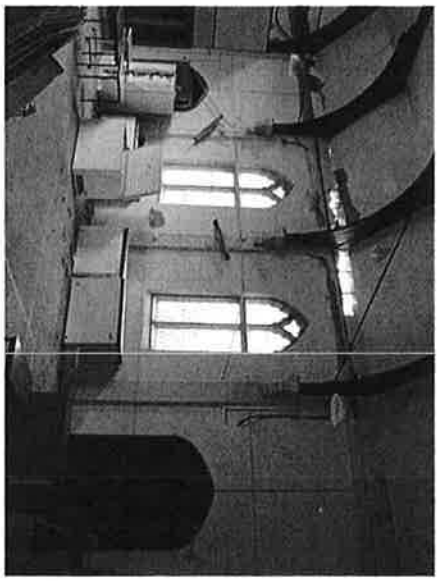

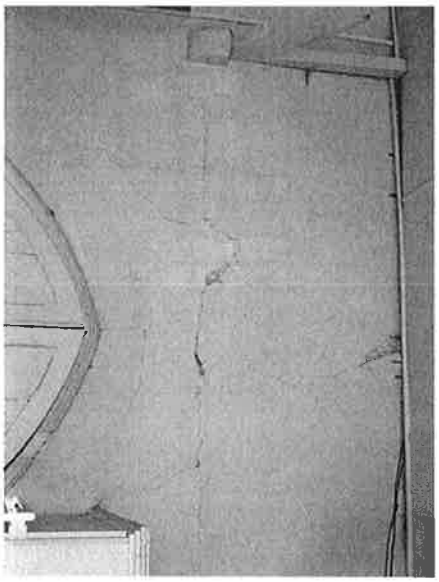

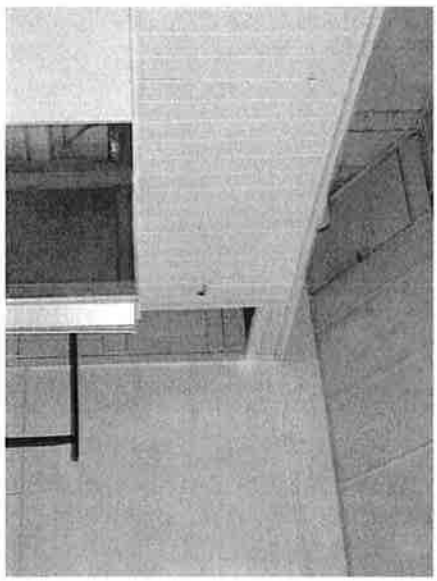

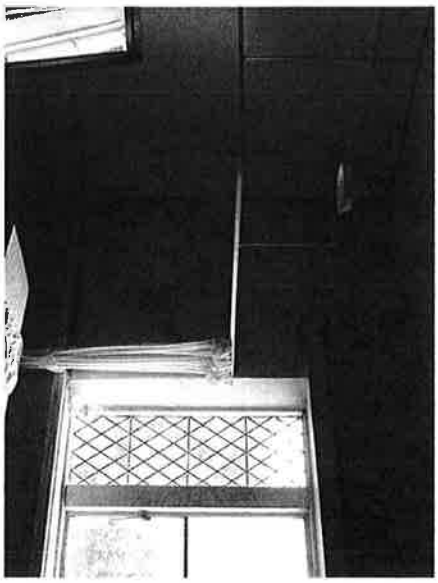


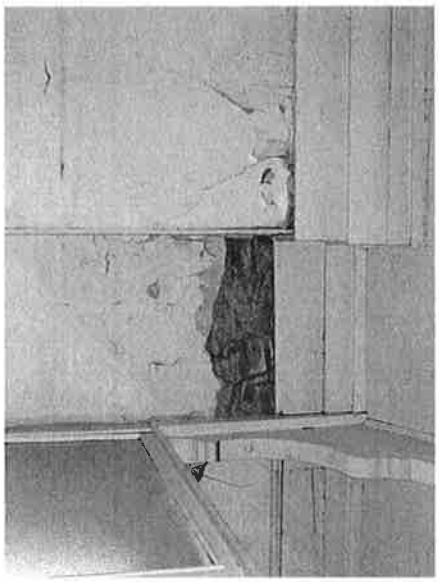
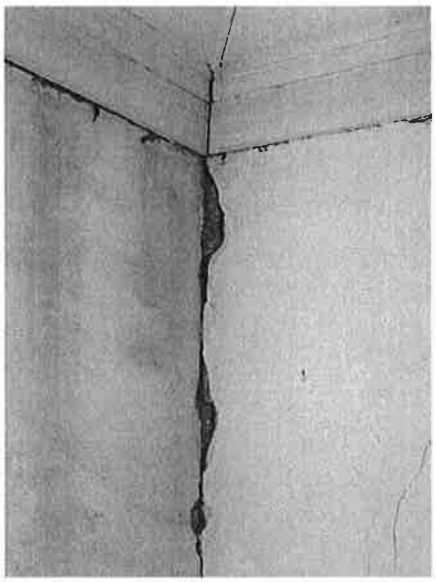

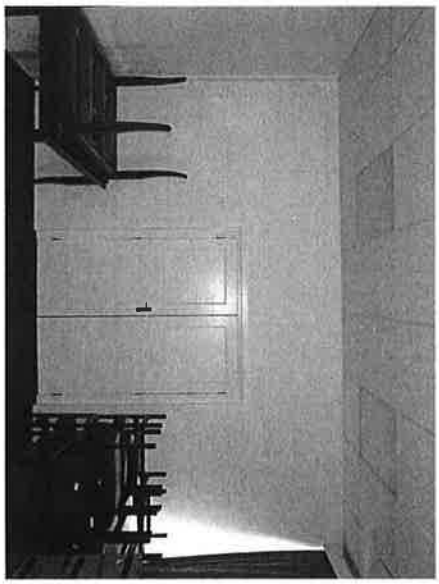

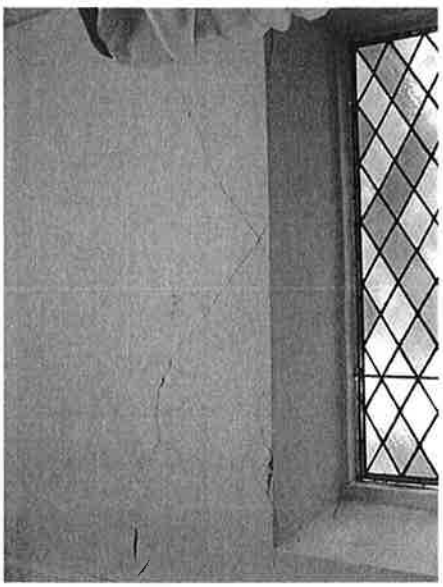

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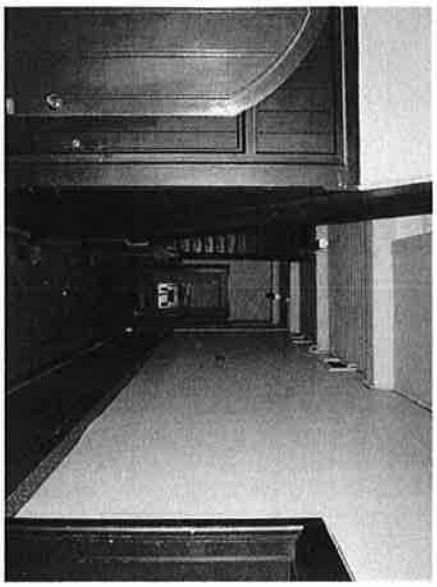

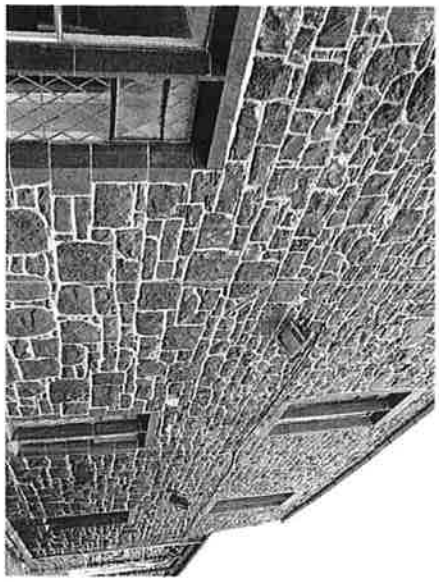
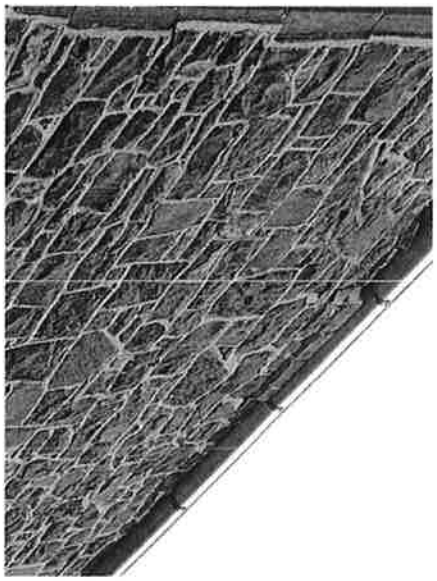
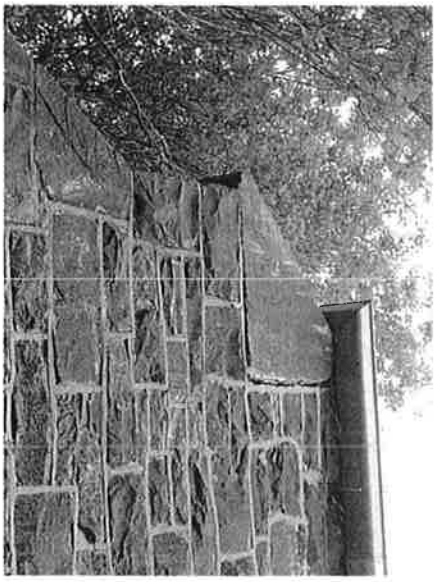
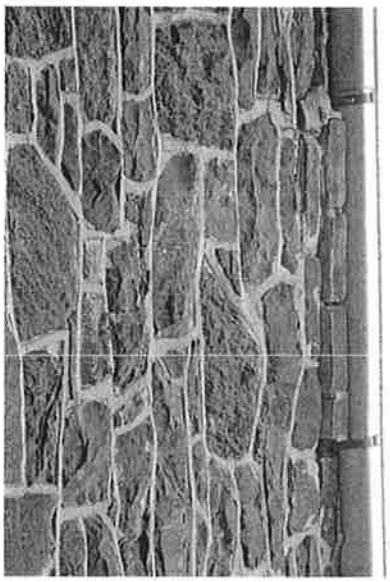
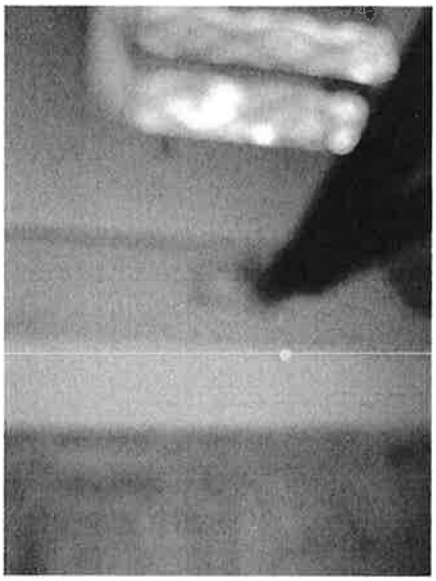

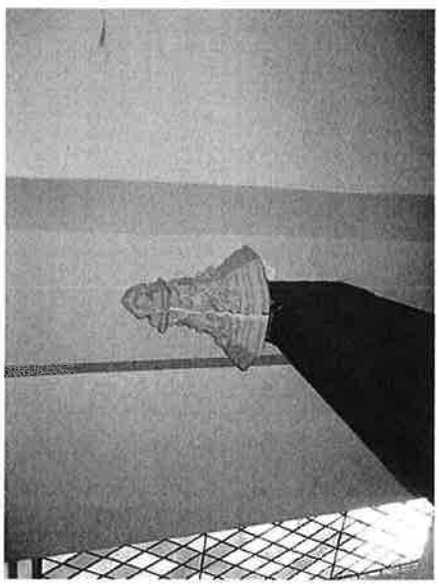
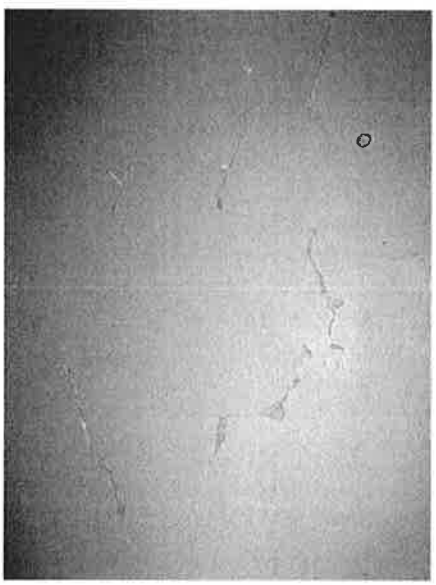
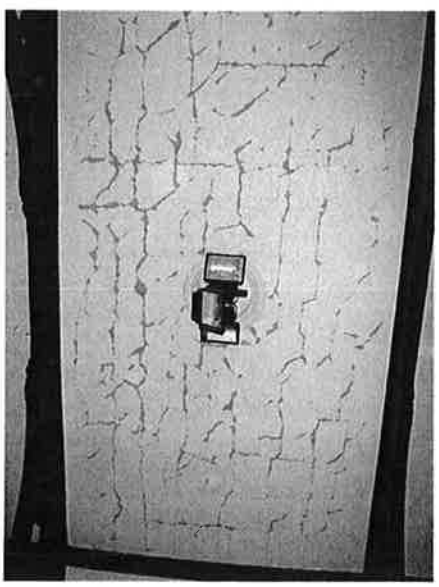




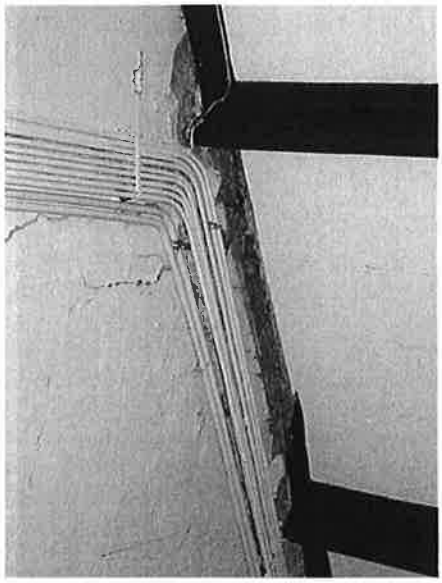

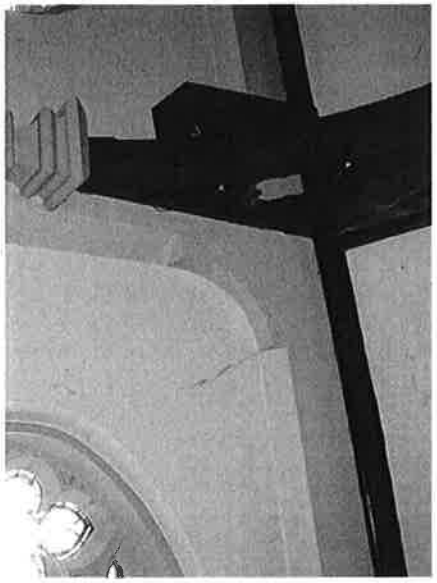
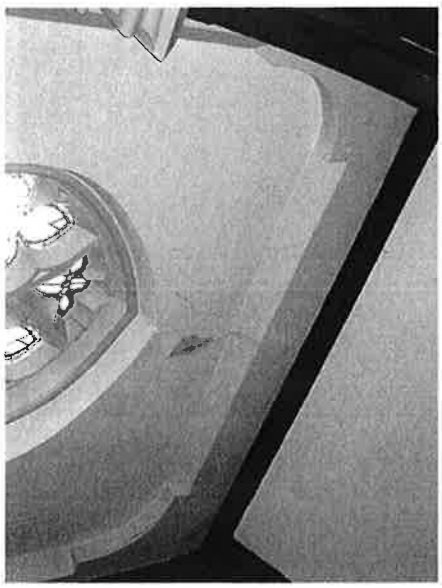
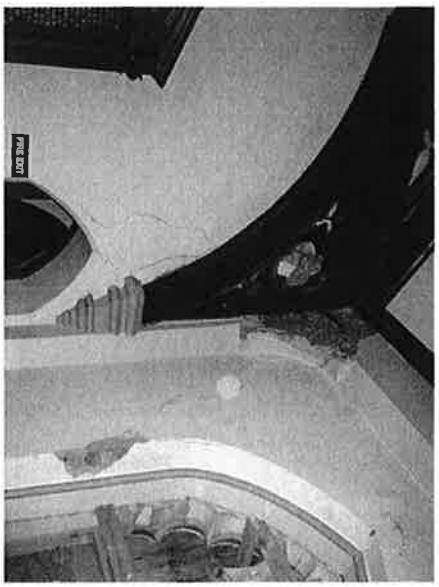
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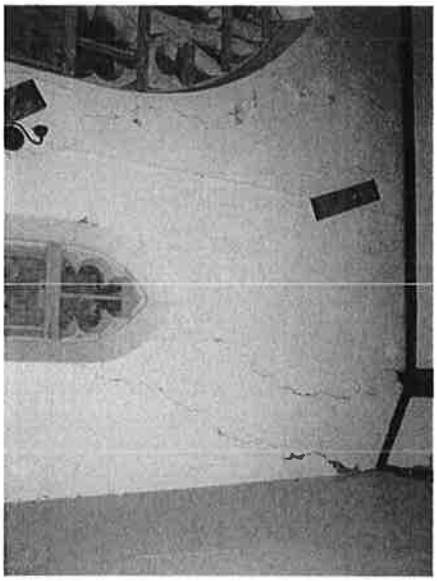
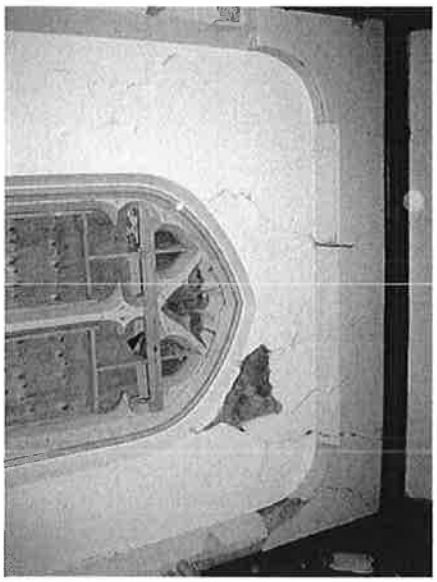
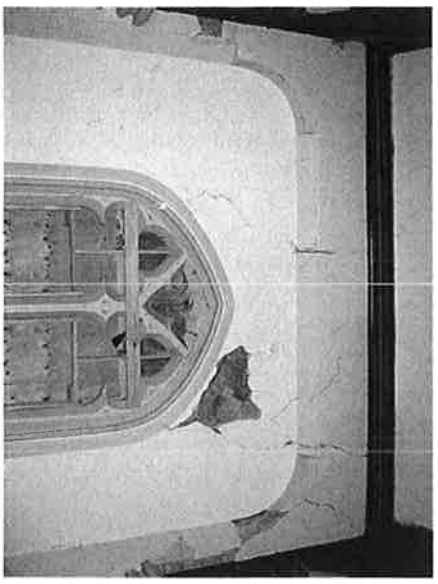
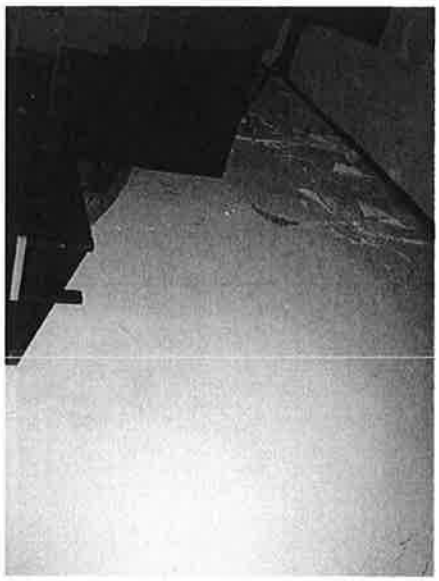
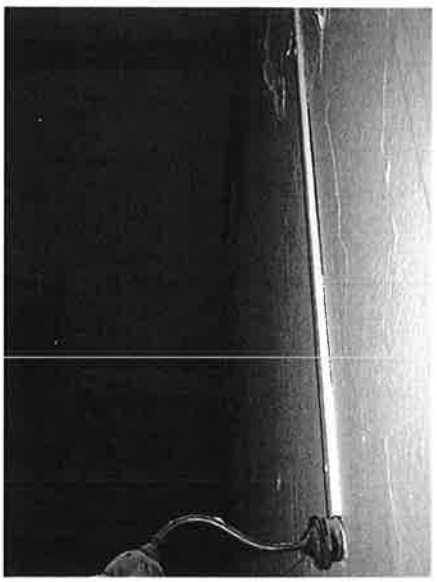
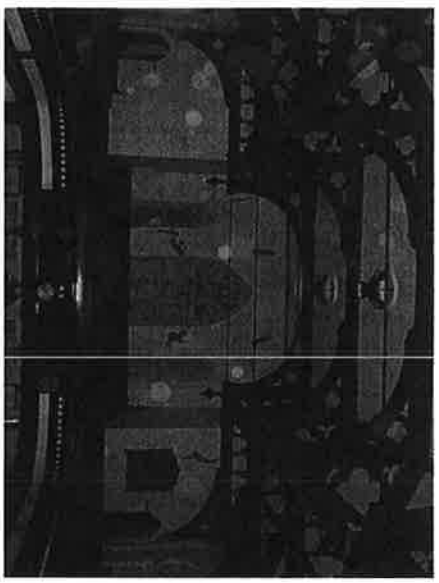
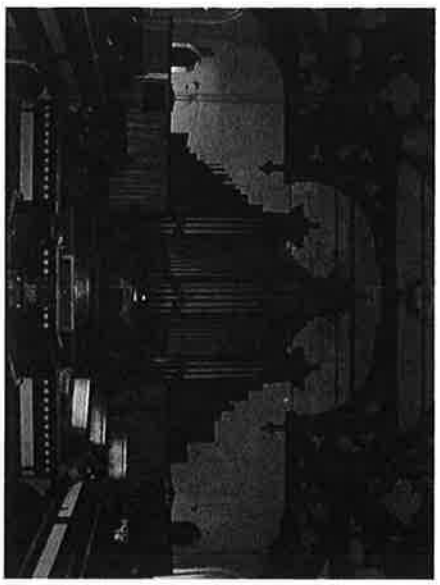
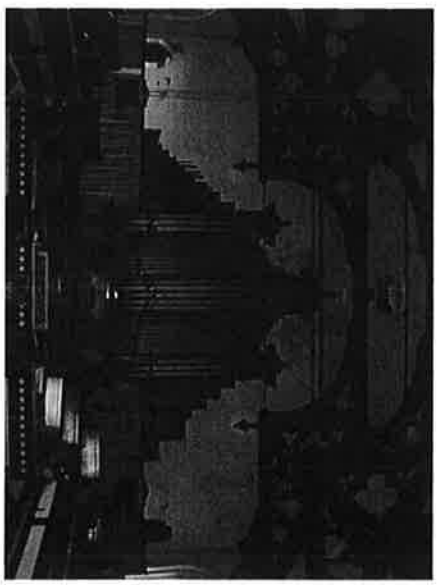




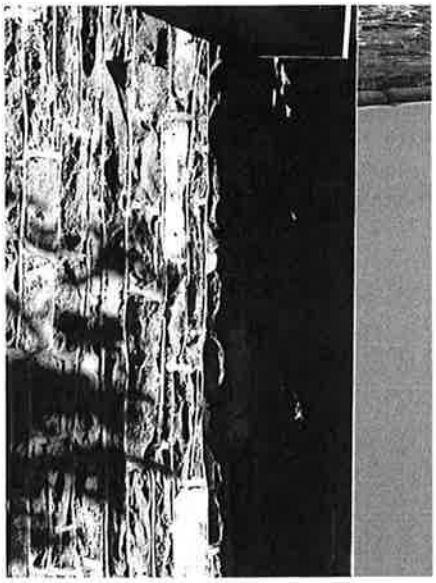



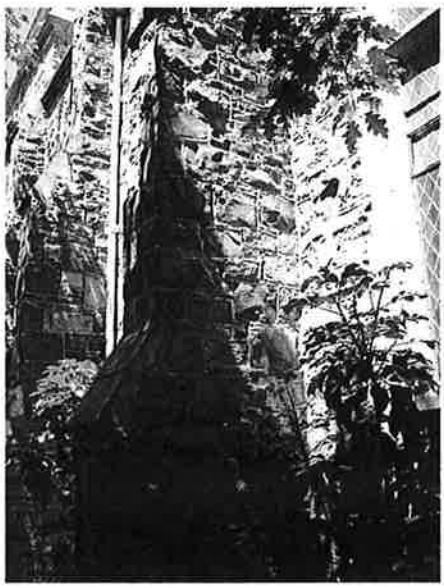

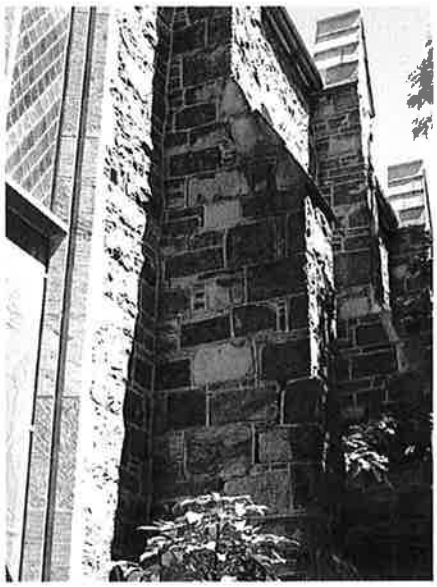

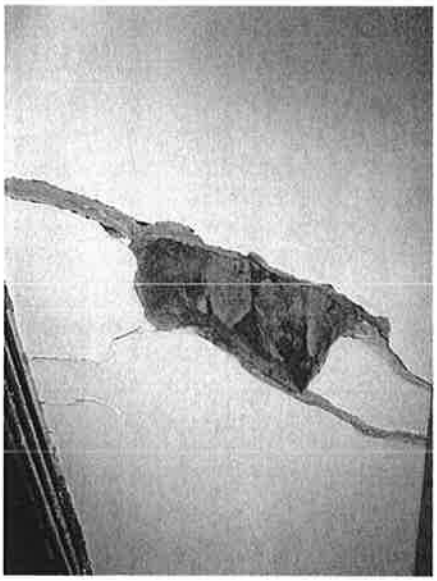

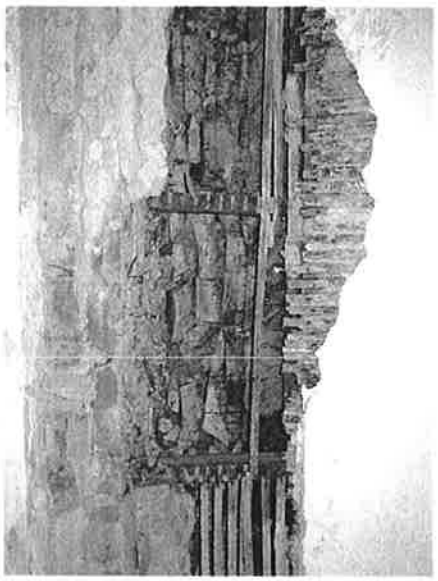

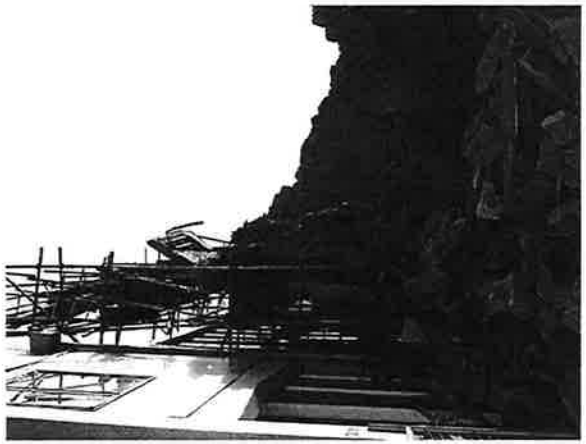
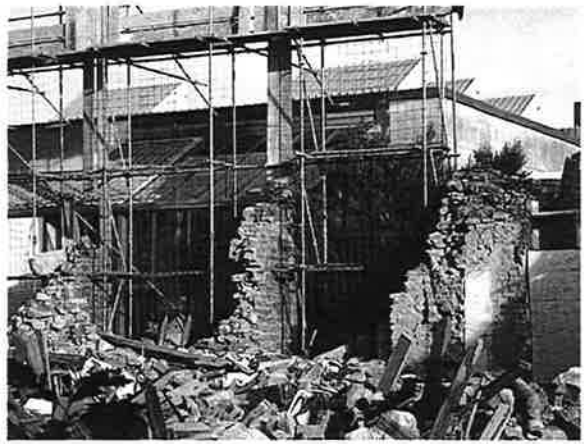

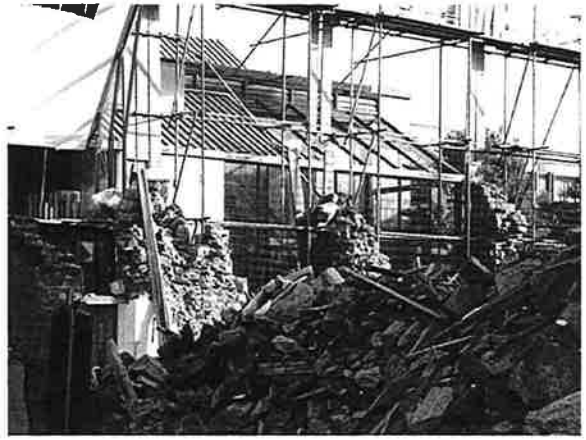
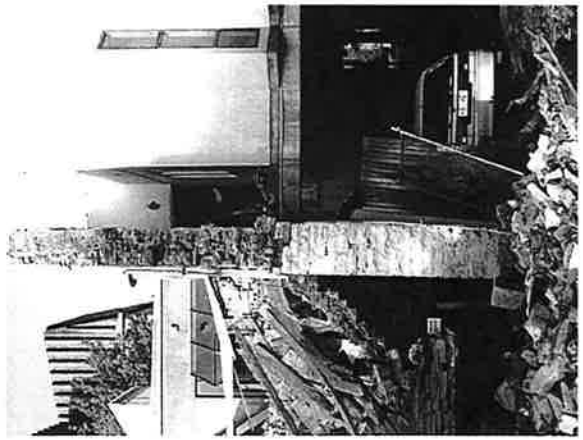


Simplified version for regular walls

Note: spreadsheet only works for bottom panel
fixed top and bottom, and top panel fixed bottom only

Where wall panels are uniform within a storey (approximately rectangular in vertical and horizontal section and without openings),and the interstorey deflection does not exceed 1% of the storey height, the following approximations may be employed. Otherwise the general proceedure should be used.

brick density= 19000 N/m^3

	fix b	fix b	fix t + b	
Storey	Parapet	2	1	
W	4370	41952	7315	weight of wall (N/m)
P	0	0	6300	weight applied at top of storey (N/m)
h	1	4.6	3.5	clear height of storey (m)
t (nom)	0.23	0.48	0.11	wall thickness (m)
t (eff)	0.225	0.468	0.105	
e (t)	N/A	0.000	0.052	t (eff)/2 or 0
e (b)	0.113	0.234	0.052	t (eff)/2 or 0
b	N/A	19634	2089	
a	N/A	96490	34851	
delta i	0.225	0.468	0.105	Instability deflection
delta m	0.135	0.281	0.063	60% instability defl
Tp (approx.)	N/A	1.76	0.93	effective period of panel (thin panels)
Tp	1.68	1.89	0.95	(s)
hi (level height)	6.8	6.2	3.5	(m)
hn (building ht)	6.8	6.2	6.8	(m)
C(Hi)	2.13	2.03	1.58	
Ci(Tp)	0.50	0.50	1.60	
Cp(Tp)	0.263	0.251	0.624	Full code parts coeff (T=Tp) with mp=1.0, assumes Christchurch Cat D soils
J	N/A	8789.7	800.4	Rotational inertia
gamma	1.427	1.287	1.427	Participation factor
Dph	0.262	0.287	0.200	Displ response (demand)
%NBS	62%	117%	38%	% current code
Cm	0.23	0.4069565	0.33	coeff to just form mechanism
Cp(0.4)	1.05	1.00	0.78	Full code parts coefficient T=0.4s, assumes Chch Cat D soils, mp=1.0

Then calculate floor reactions from weight and Cm and Cp(0.4)

Based on section 10.2.9

Requires strength reduction factors to be applied

Maximum nominal shear strength

c	0.1	Cohesion, Refer table 10.2, MPa	
z	1650	Distance from compression fibre to action of N, generally half the wall/pier length, mm	
t	250	Thickness, mm	
μ	0.4	Refer table 10.2, Coeff of friction	
N	182000	Axial Force, N	
M	30970	Moment, kN.m, at point of maximum moment	Only used to calculate aspect ratio
V	5631	Shear, kN, at point of maximum moment	Only used to calculate aspect ratio
d	3300	Wall length, mm	
α	1.667	Effective aspect ratio (=M/Vd)	
f,bt	1.5	Direct tensile strength of brick, refer Table 10.2 or from testing, refer section 10.2.9, MPa	

Vs	60172	N	
Vj	58238	N	
Vb	230501	N	
Vn	58.24	kN	70.59 kPa

Use with caution- numbers appear low
cf 230 kPa with phi =0.7 from old Red book

Maximum nominal flexural resistance

fc	4	MPa
Mn	280.82	kN.m

Simplified version for regular walls

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P	0	0	6300	weight applied at top of storey (N/m)
h	1	8.3	3.5	clear height of storey (m)
t (nom)	0.23	0.6	0.11	wall thickness (m)
t (eff)	0.225	0.585	0.105	
e (t)	N/A	0.000	0.052	t (eff)/2 or 0
e (b)	0.113	0.293	0.052	t (eff)/2 or 0
b	N/A	55353	2089	
a	N/A	392673	34851	
delta i	0.225	0.585	0.105	Instability deflection
delta m	0.135	0.351	0.063	60% instability defl
Tp (approx.)	N/A	2.36	0.93	effective period of panel (thin panels)
Tp	1.68	2.45	0.95	(s)
hi (level height)	6.8	11.6	3.5	(m)
hn (building ht)	6.8	11.6	6.8	(m)
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Ci(Tp)	0.50	0.50	1.60	
Cp(Tp)	0.263	0.361	0.624	Full code parts coeff (T=Tp) with mp=1.0, assumes Christchurch Cat D soils
J	N/A	59773.0	800.4	Rotational inertia
gamma	1.427	1.390	1.427	Participation factor
Dph	0.262	0.747	0.200	Displ response (demand)
%NBS	62%	56%	38%	% current code
Cm	0.23	0.2819277	0.33	coeff to just form mechanism
Cp(0.4)	1.05	1.45	0.78	Full code parts coefficient T=0.4s, assumes Chch Cat D soils, mp=1.0

Then calculate floor reactions from weight and Cm and Cp(0.4)

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Then calculate floor reactions from weight and Cm and Cp(0.4)

Project 10715
Durham St Methodist Church

Benchmark level RL = 10.000 9.953

R.L + B.S = H.O.C and H.O.C - F.S = R.L

BS	IS	FS	HOC	RL	Notes	
1779.000			11.779	10.000	A1	47
	1771.000		11.779	10.008	A2	55
	1730.000		11.779	10.049	A3	96
	1763.000		11.779	10.016	A4	63
	1784.000		11.779	9.995	A5	42
	1755.000		11.779	10.024	A6	71
	1749.000		11.779	10.030	A7	77
	1744.000		11.779	10.035	A8	82
	1750.000		11.779	10.029	A9	76
	1776.000		11.779	10.003	A10	50
	1756.000		11.779	10.023	A11	70
	1759.000		11.779	10.020	A12	67
	1741.000		11.779	10.038	A13	85
	1734.000		11.779	10.045	A14	92
	1774.000		11.779	10.005	A15	52
	1758.000		11.779	10.021	A16	68
	1753.000		11.779	10.026	A17	73
	1792.000		11.779	9.987	A18	34
	1766.000		11.779	10.013	A19	60
	1765.000		11.779	10.014	A20	61
	1755.000		11.779	10.024	A21	71
	1750.000		11.779	10.029	A22	76
	1786.000		11.779	9.993	A23	40
	1780.000		11.779	9.999	A24	46
	1768.000		11.779	10.011	A25	58
	1816.000		11.779	9.963	A26	10
	1787.000		11.779	9.992	A27	39
	1769.000		11.779	10.010	A28	57
	1760.000		11.779	10.019	A29	66
	1764.000		11.779	10.015	A30	62
	1798.000		11.779	9.981	A31	28
	1797.000		11.779	9.982	A32	29
	1783.000		11.779	9.996	A33	43
	1826.000		11.779	9.953	A34	0
	1793.000		11.779	9.986	A35	33
	1775.000		11.779	10.004	A36	51
	1807.000		11.779	9.972	A37	19
	1798.000		11.779	9.981	A38	28
	1791.000		11.779	9.988	A39	35
	1824.000		11.779	9.955	A40	2
	1808.000		11.779	9.971	A41	18
	1787.000		11.779	9.992	A42	39
	1795.000		11.779	9.984	A43	31
	1817.000		11.779	9.962	A44	9
						9.977
1745.000			11.745	10.000	B1	23
	1752.000		11.745	9.993	B2	16
	1741.000		11.745	10.004	B3	27
	1740.000		11.745	10.005	B4	28
	1744.000		11.745	10.001	B5	24
	1744.000		11.745	10.001	B6	24
	1756.000		11.745	9.989	B7	12
	1748.000		11.745	9.997	B8	20
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	1742.000		11.745	10.003	B12	26
	1755.000		11.745	9.990	B13	13
	1741.000		11.745	10.004	B14	27
	1739.000		11.745	10.006	B15	29
	1741.000		11.745	10.004	B16	27
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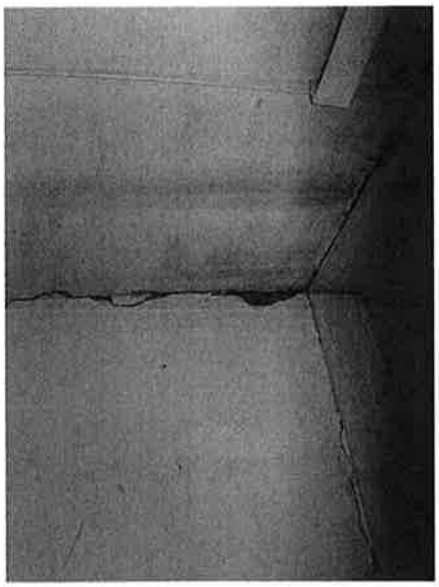
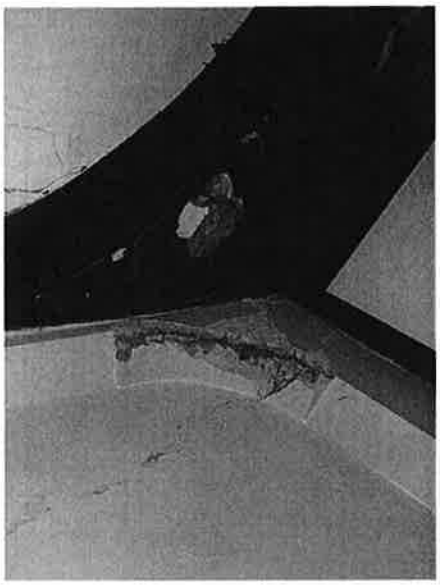
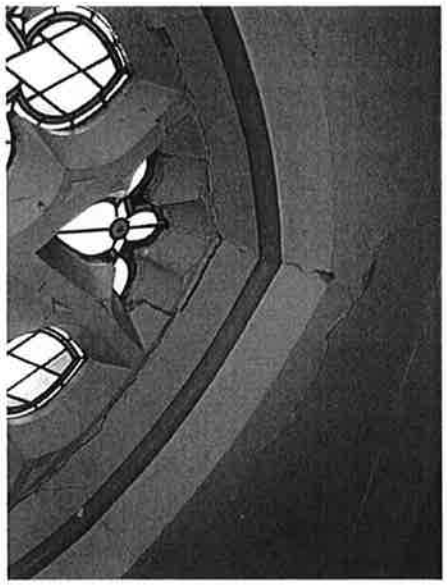
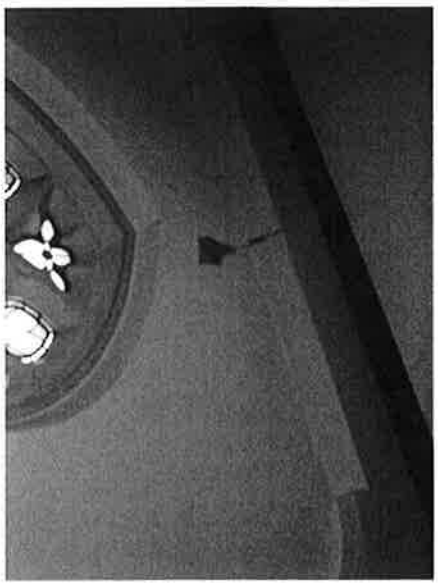
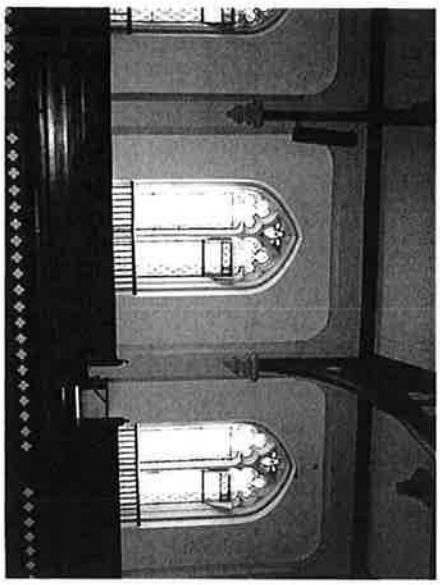
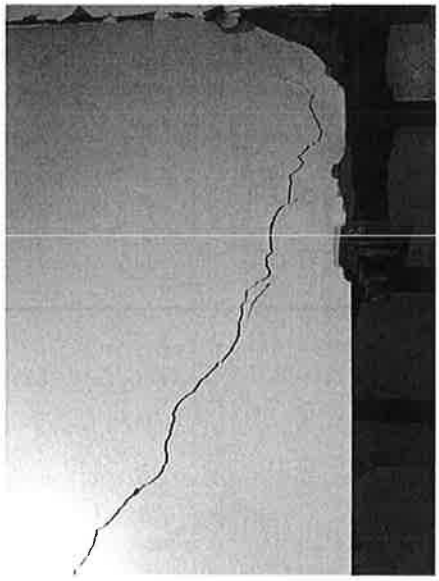
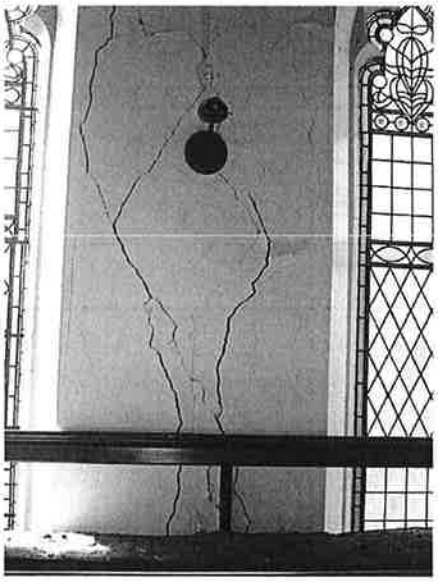
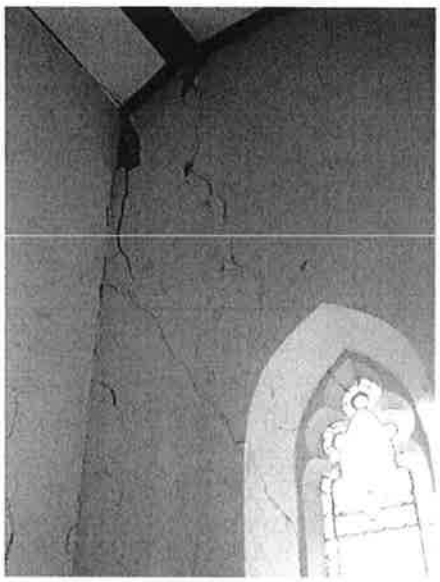
	1768.000		11.745	9.977	B19	0
	1741.000		11.745	10.004	B20	27
	1739.000		11.745	10.006	B21	29
	1735.000		11.745	10.010	B22	33
	1743.000		11.745	10.002	B23	25
	1750.000		11.745	9.995	B24	18
	1752.000		11.745	9.993	B25	16
	1744.000		11.745	10.001	B26	24
	1745.000		11.745	10.000	B27	23
	1744.000		11.745	10.001	B28	24
	1742.000		11.745	10.003	B29	26

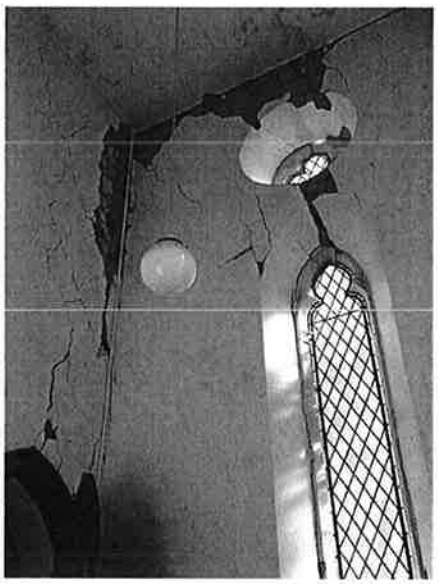


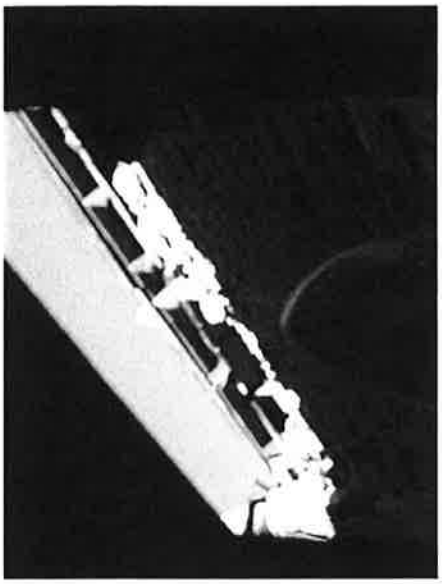
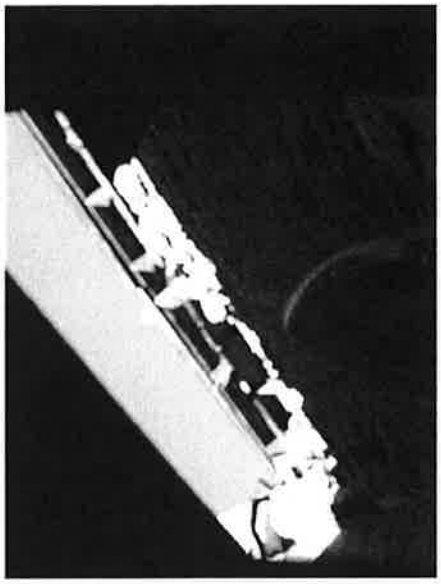




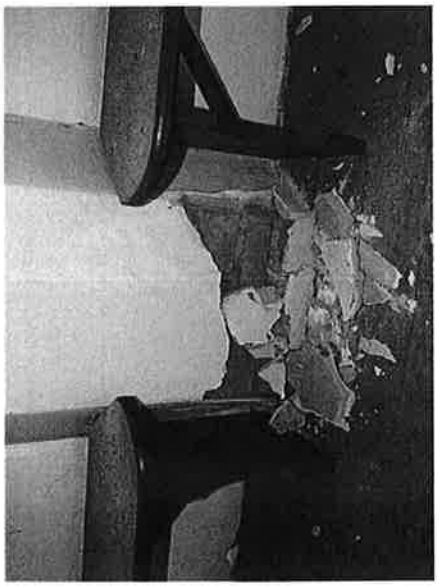





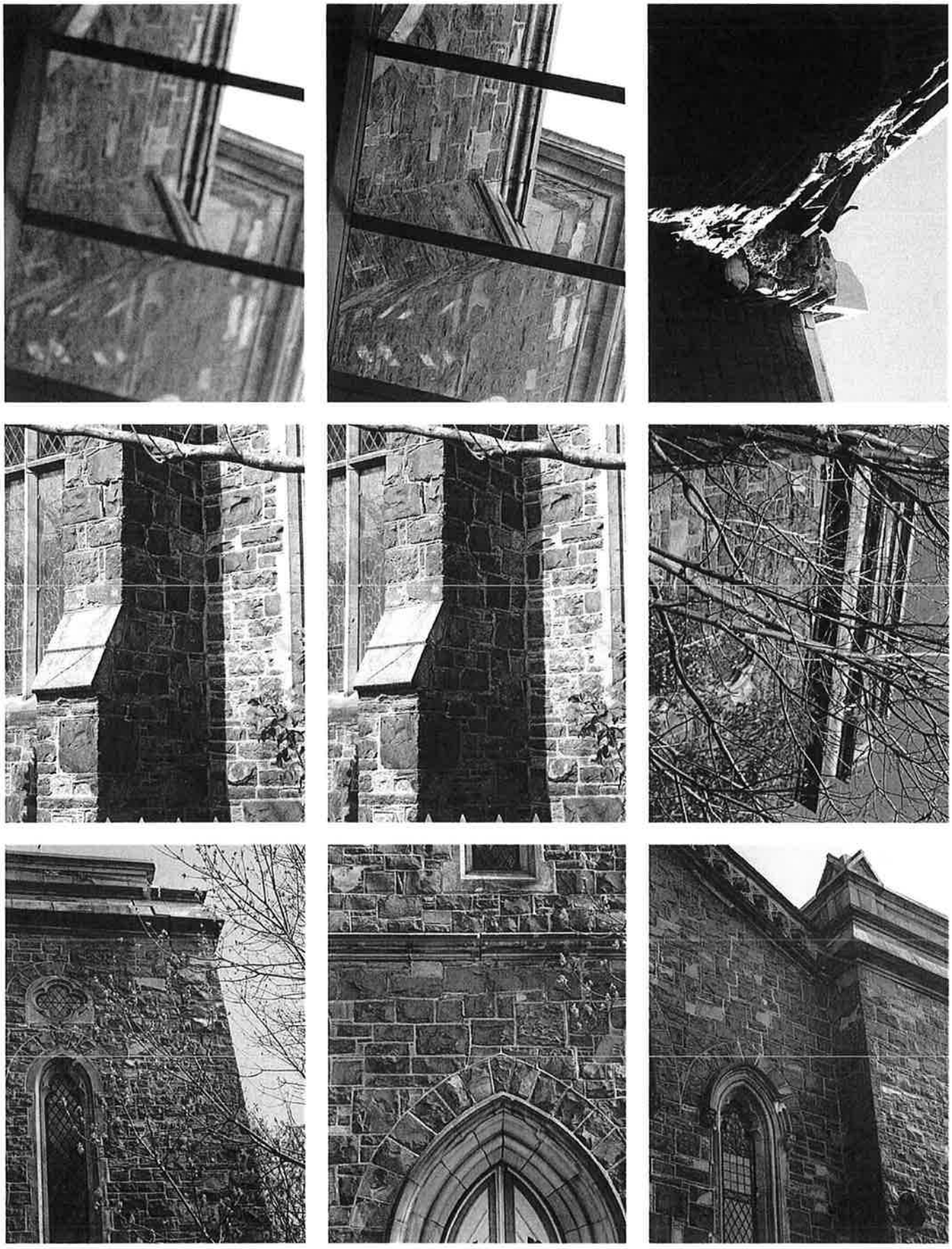




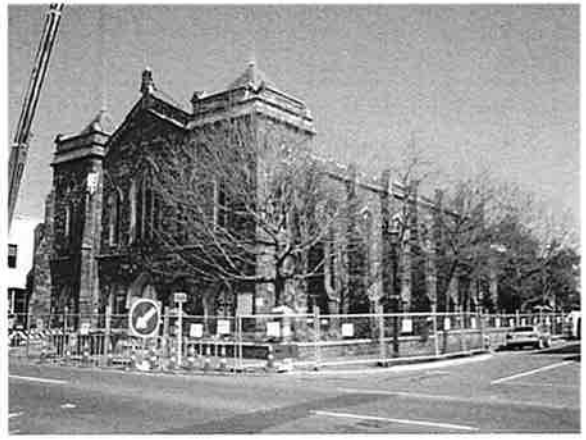


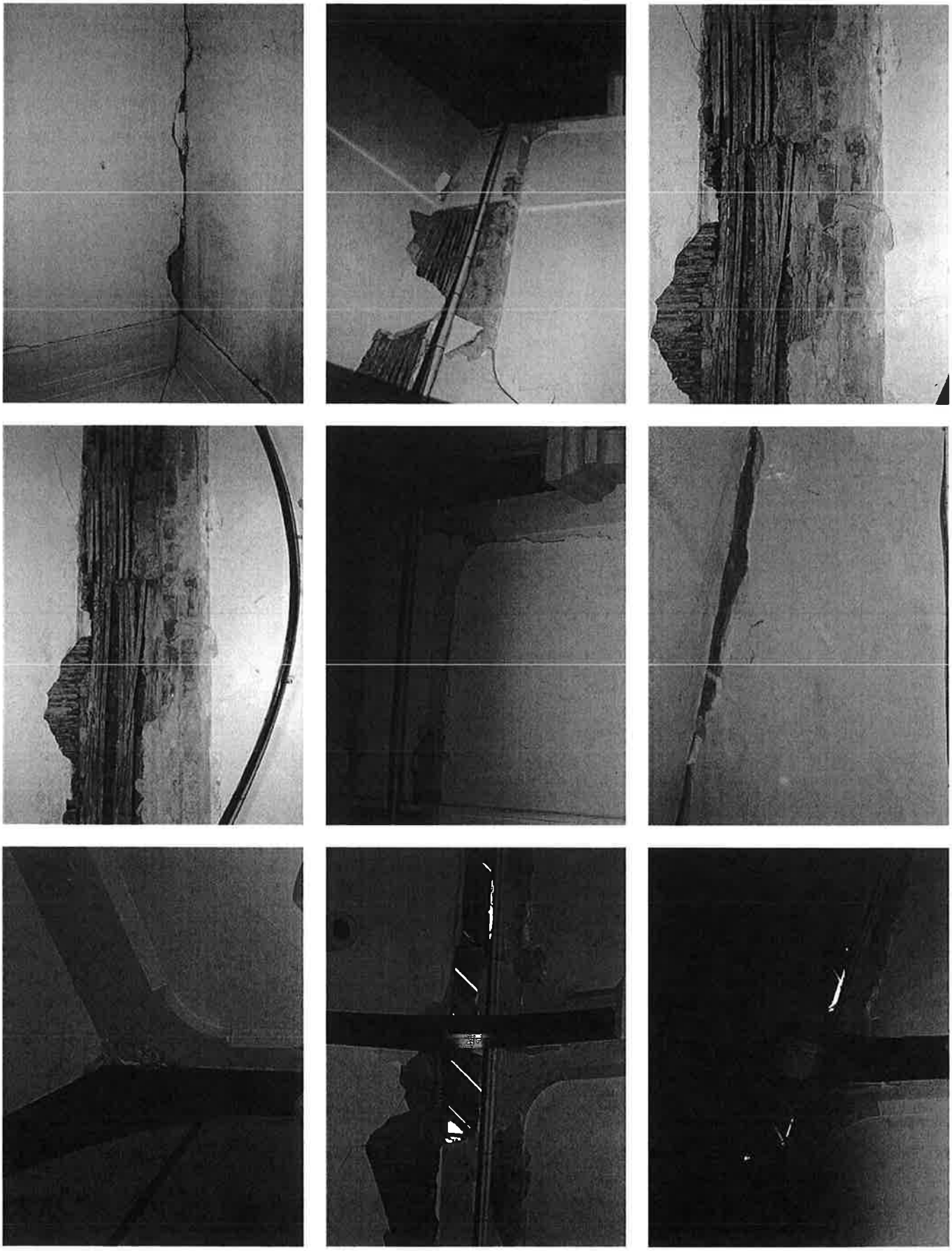


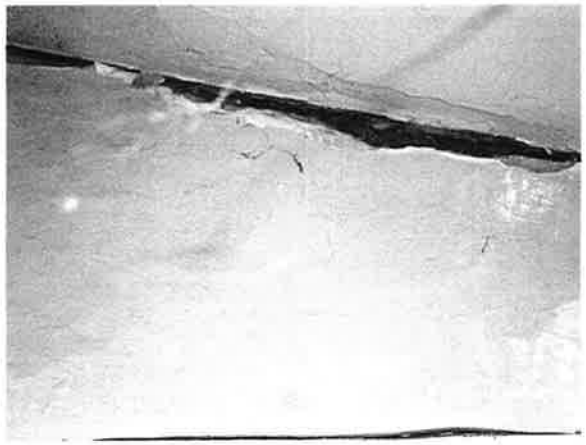
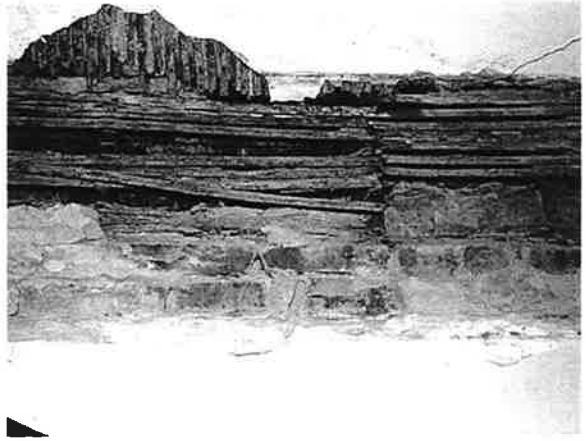
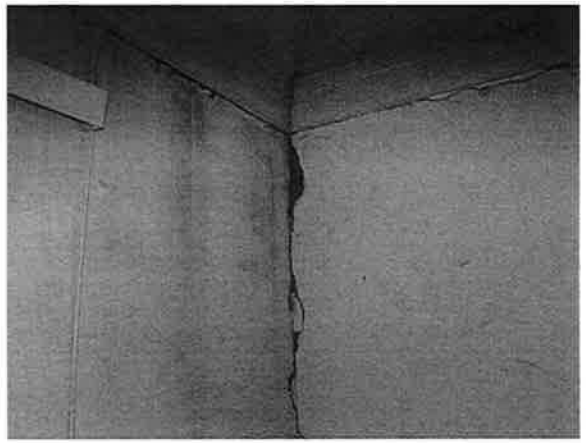
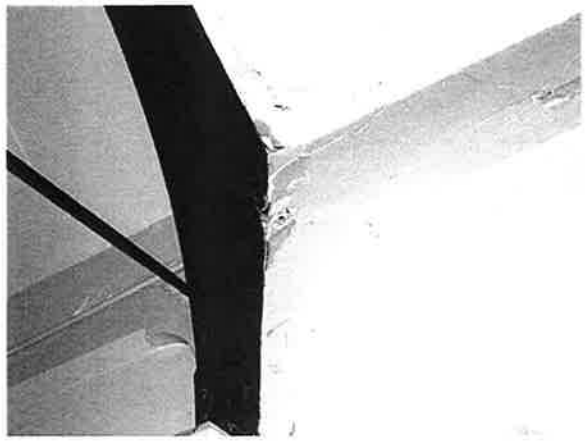
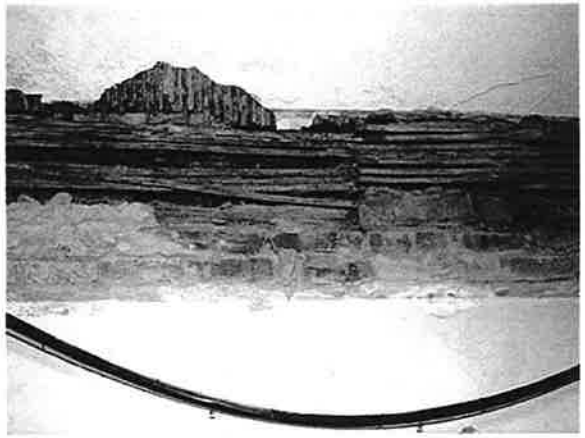
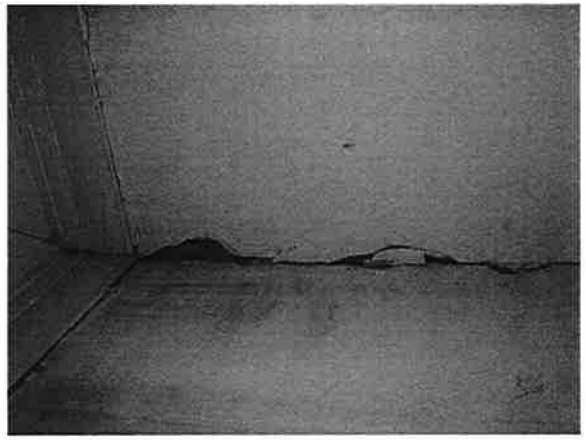
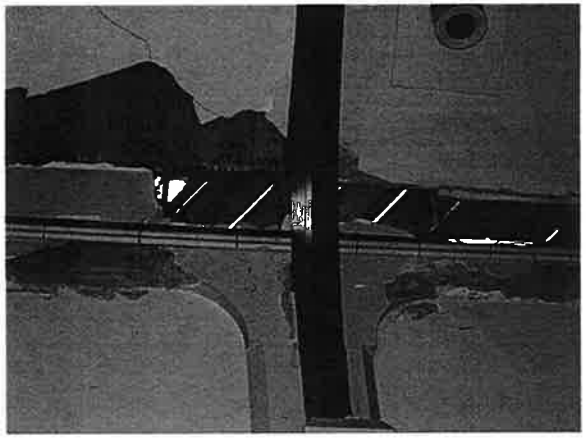
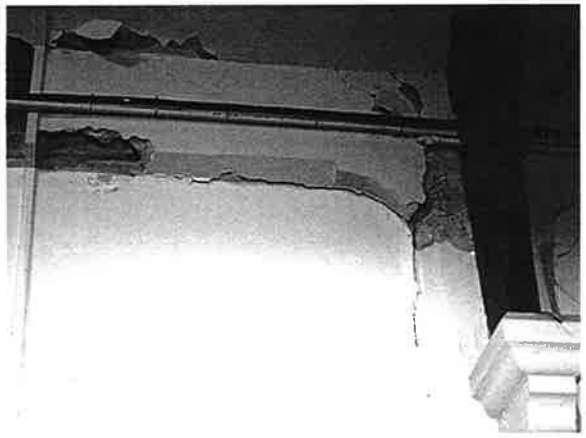

TITAN


TITAN



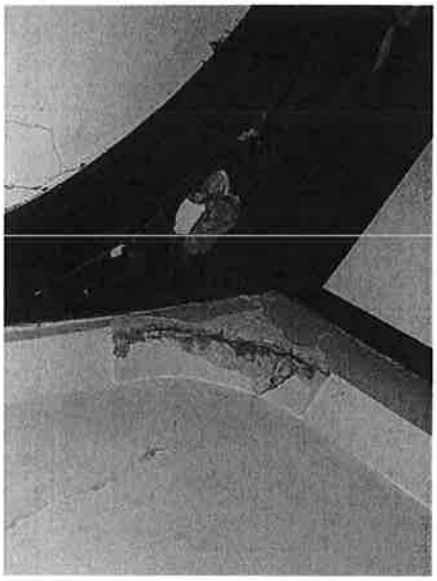
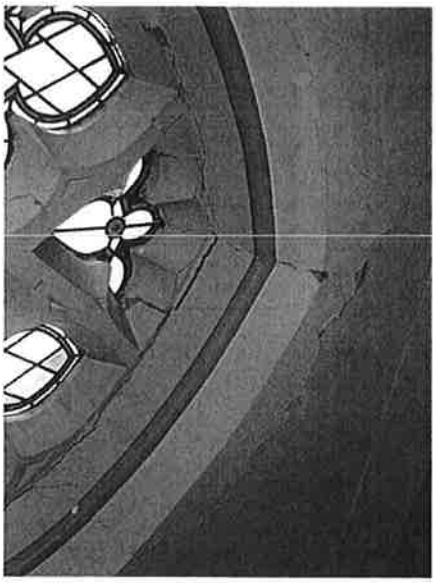
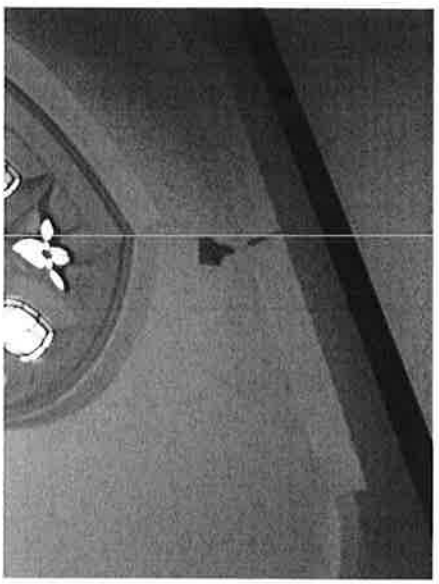
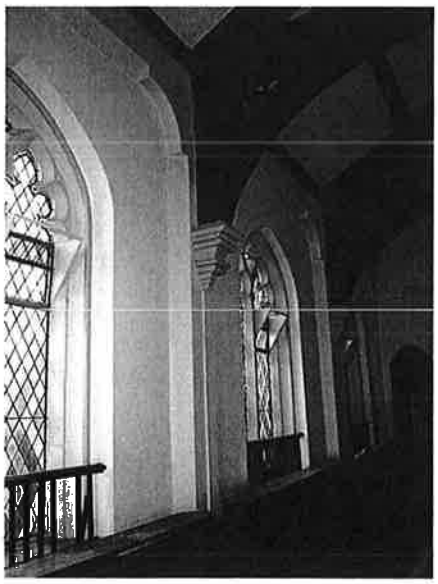

Methodist
Mission

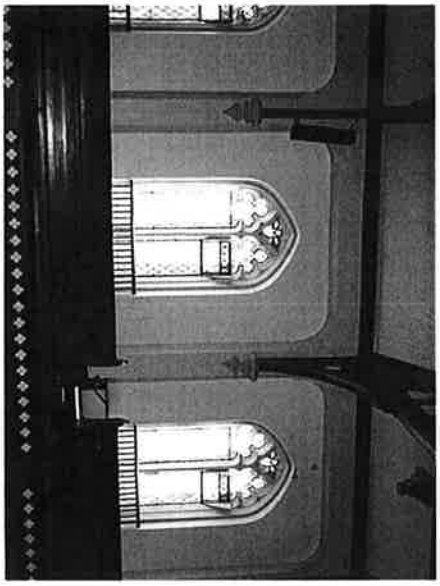
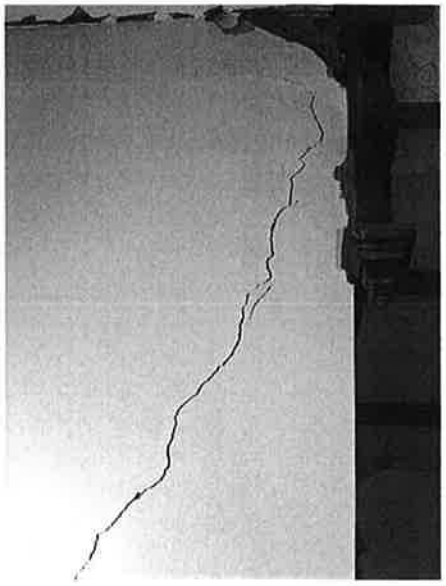
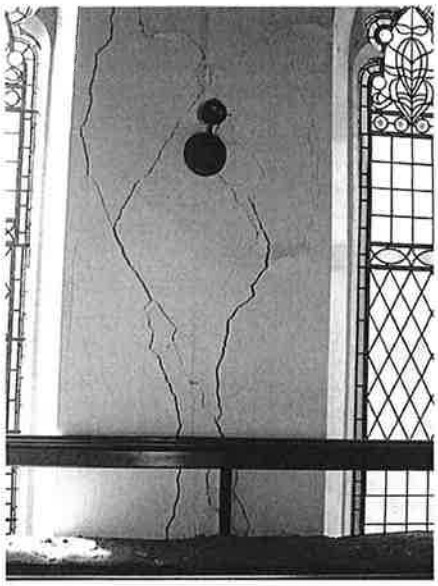
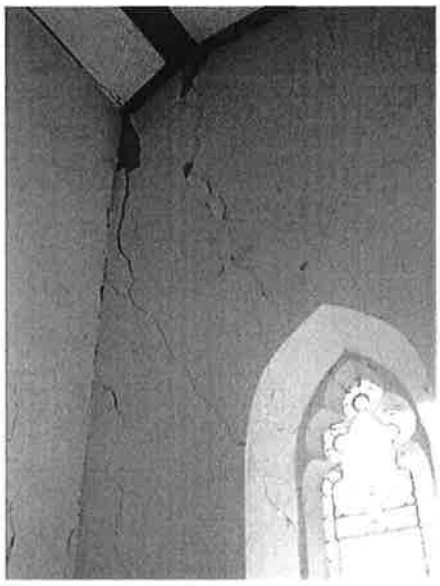


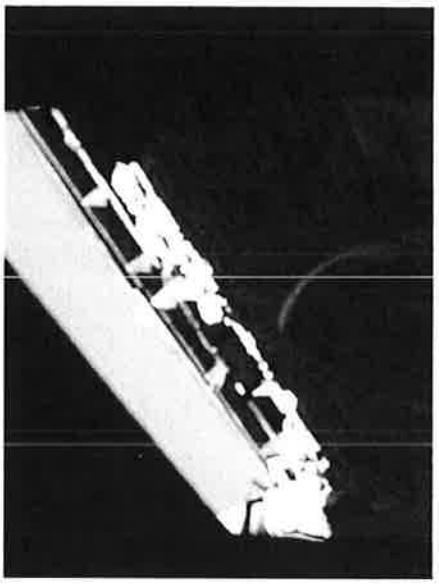
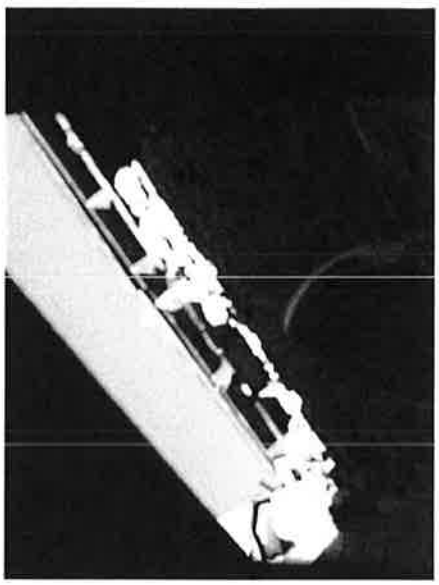
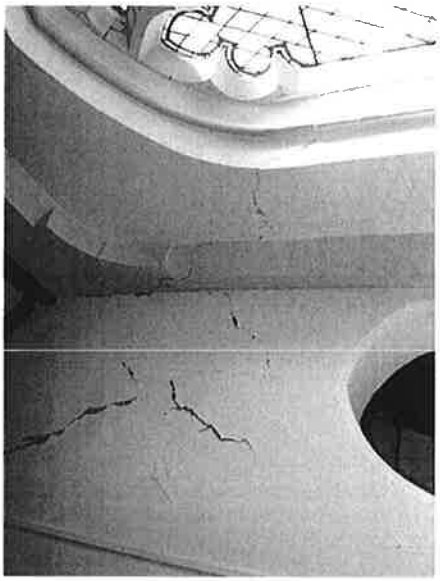


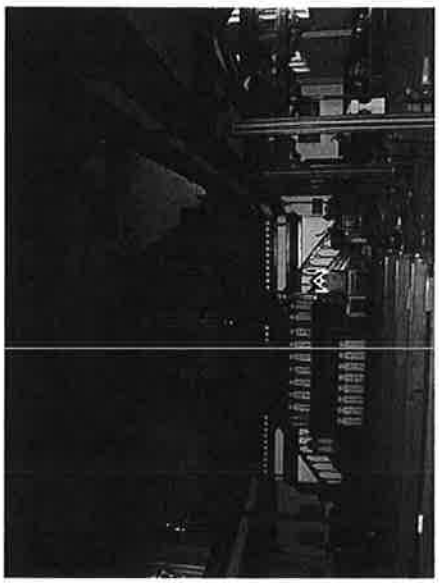


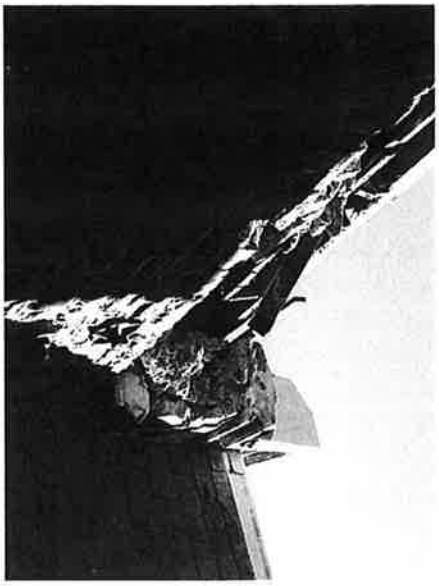





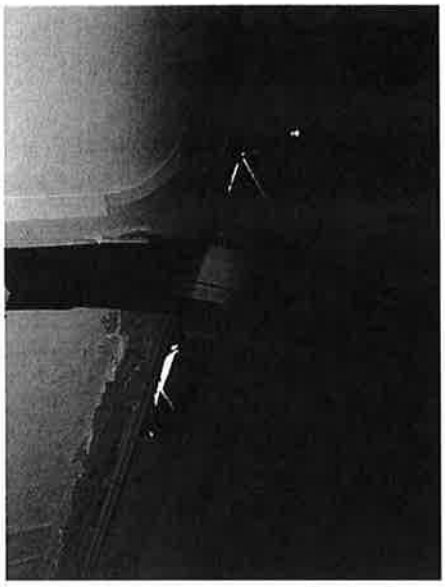












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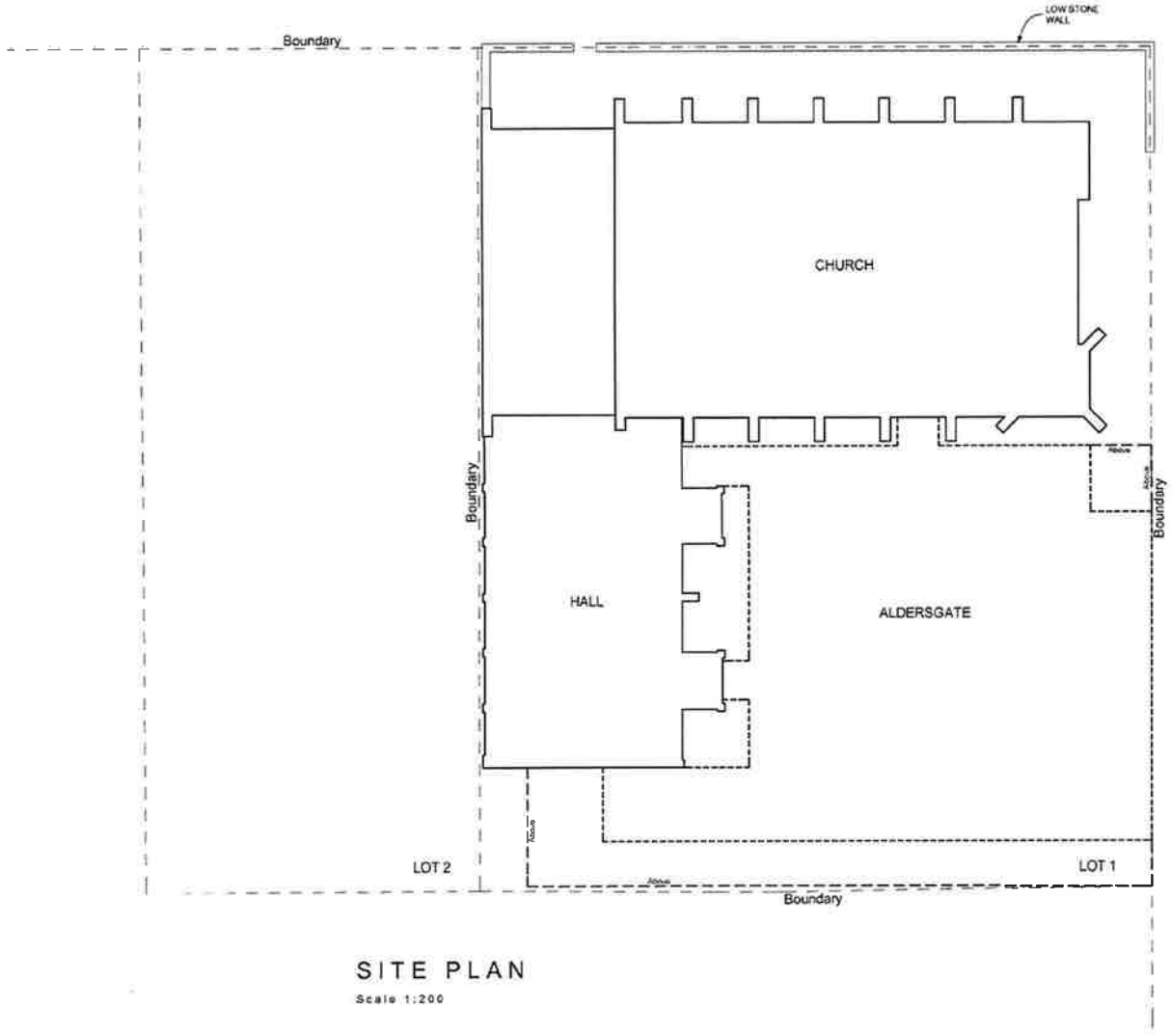
CHESTER STREET WEST

NORTH



SITE PLAN

Scale 1:200

LEGAL DESCRIPTION:
Lot 1 Deposited Plan 51328

Area: 2048 square metres more or less

FULTON ROSS
team architecture
Fulton Ross Team Architecture
The Arts Centre, PO Box 945, Christchurch
Telephone 03 366 7105, Facsimile 03 365 5764
Email admin@fra.co.nz

Project Title
Durham Street Methodist Church
CHRISTCHURCH

Drawing Title
SITE PLAN

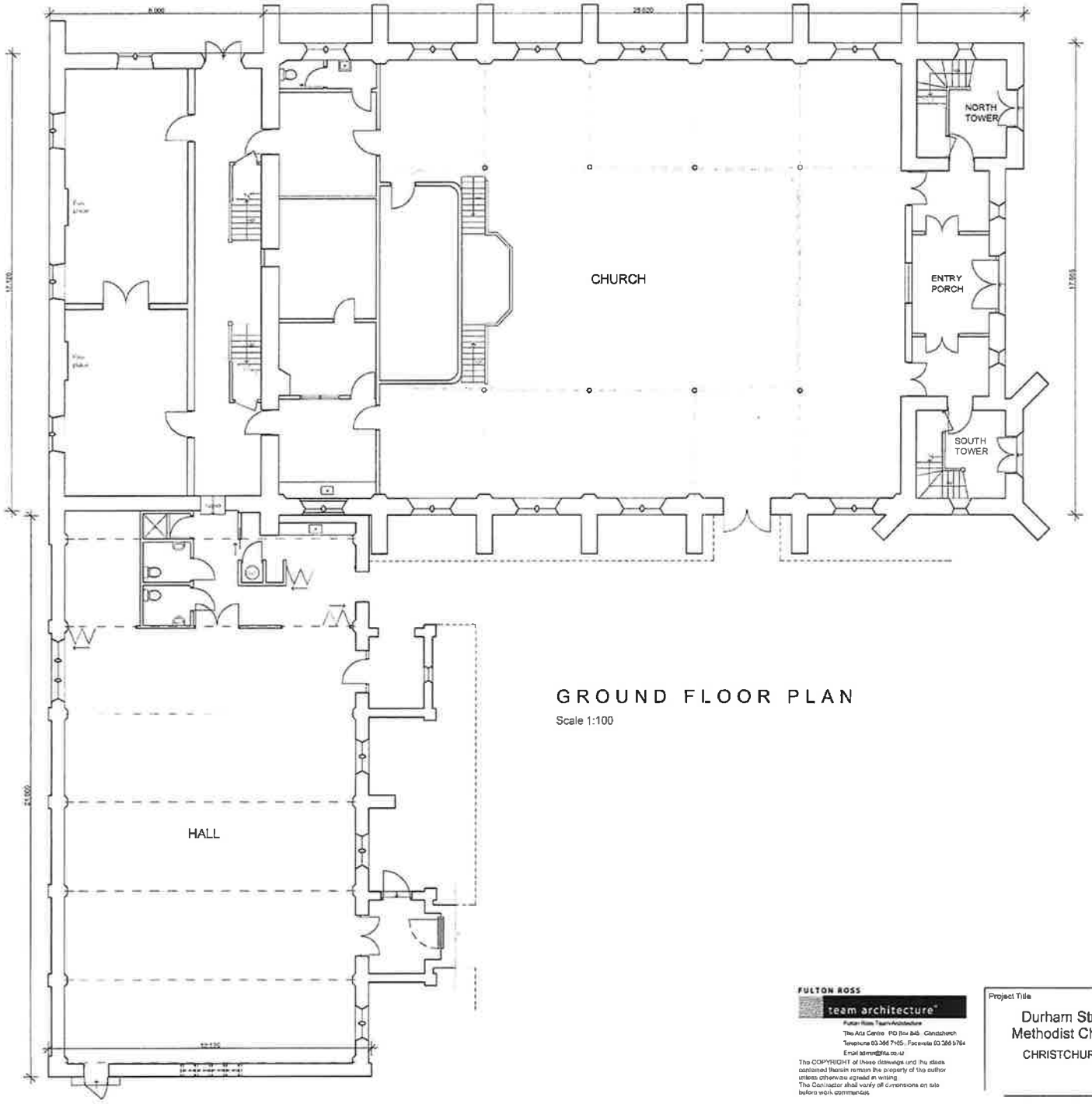
scale
A2 @ 1:200

Drawn by MO
Date January 2011

Checked WF
Date January 2011

Issue AS-BUILT
Date 3rd February 2011
C.A.D file
Project No. 5461 E

Sheet No.
A1.0
Rev



Revisions

No	Date	Subject

NORTH

GROUND FLOOR PLAN

Scale 1:100

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Project Title
Durham Street Methodist Church
CHRISTCHURCH

Drawing Title
GROUND FLOOR PLAN

scale
A2 @ 1:100

Drawn by MD
Date January 2011

Checked WF
Date January 2011

Issue AS-BUILT

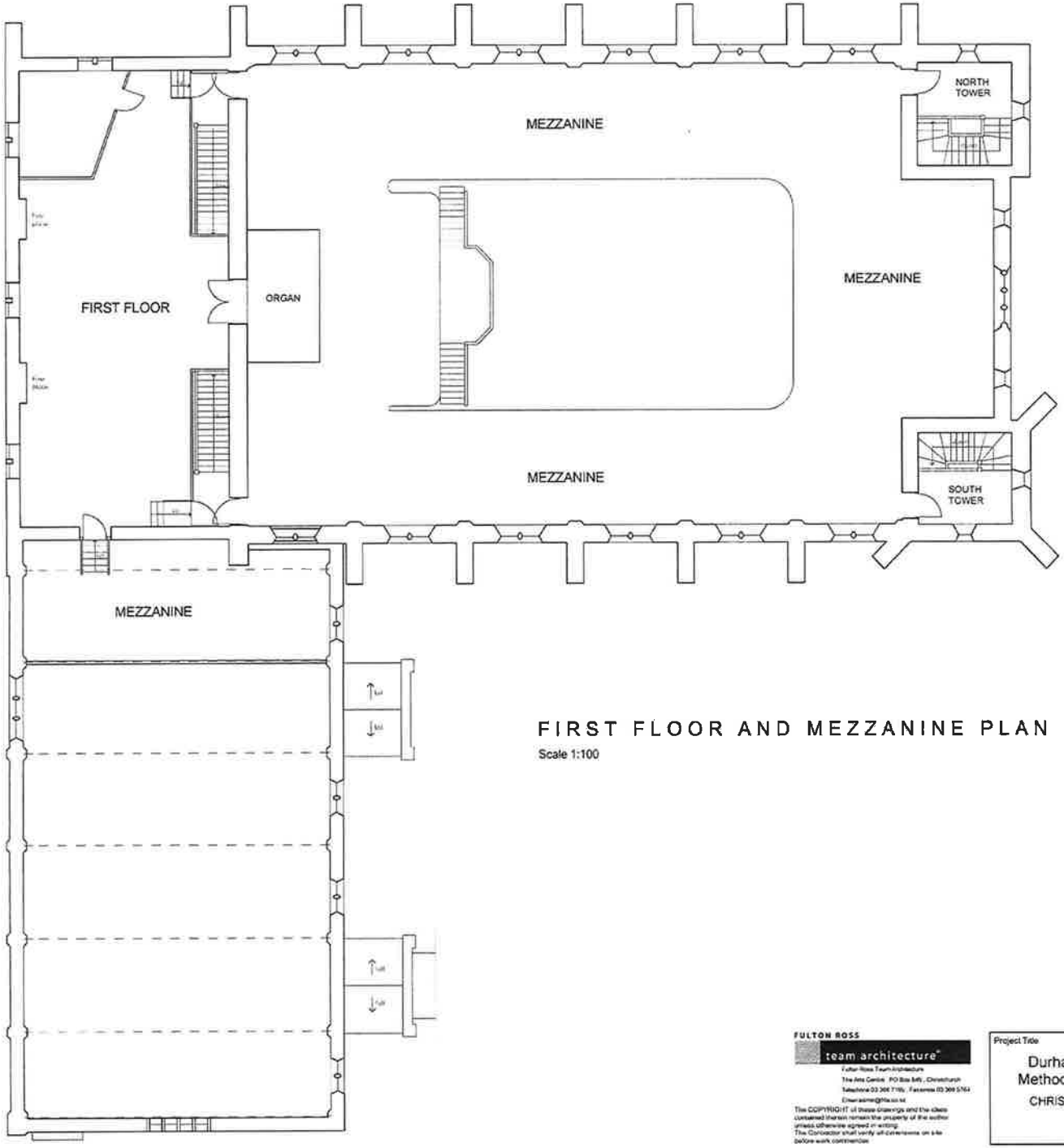
Date 3rd February 2011

Sheet No.
A1.1

C.A.D file

Project No.
5461 E

Rev



Revisions

No	Date	Subject

NORTH

FIRST FLOOR AND MEZZANINE PLAN

Scale 1:100

FULTON ROSS team architecture

Project Title
Durham Street Methodist Church
CHRISTCHURCH

Drawing Title
FIRST FLOOR PLAN

scale
A2 @ 1:100

Drawn by MD
Date January 2011

Checked WF
Date January 2011

Issue AS-BUILT

Date 3rd February 2011

Sheet No.
A1.2

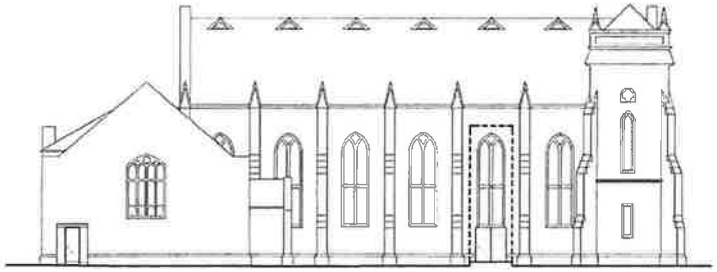
C.A.D file

Project No.
5461 E

Rev

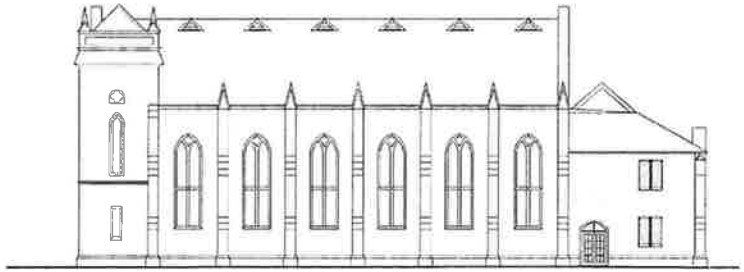
Revisions

No.	Date	Subject



SOUTH ELEVATION

EAST ELEVATION



NORTH ELEVATION

WEST ELEVATION

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Project Title
Durham Street Methodist Church
CHRISTCHURCH

Drawing Title
ELEVATIONS

scale
A2 @ 1:200

Drawn by MD
Date January 2011
Checked WF
Date January 2011

Issue AS-BUILT
Date 3rd February 2011
C.A.D file
Project No. 5461 E
Sheet No. A1.3
Rev

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Project 10715 – 17 February 2011

Methodist Church Hall
Durham Street
Christchurch

Structural Assessment & Strengthening Report

Contents

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17 February 2011

Tim Fahy
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Christchurch 8140

Email: tim.fahy@arrowinternational.co.nz

Dear Tim,

Re: Durham Street Methodist Church Hall
Structural Assessment & Strengthening Report



Introduction

Structex Metro has been engaged to carry out a seismic assessment and report of the existing Durham Street Methodist Church Hall building in Christchurch.

The purpose of this report is to summarise the building damage caused by the recent Darfield earthquake on 4 September 2010, and assess the building to determine if it is earthquake prone. If the building is earthquake prone, strengthening options to 33% current code, and 67% current code are provided.

Walk-over surveys of the building were carried out in January 2011. A previous report has been written by Structex dated 4 October 2010 summarising damage and outlining possible repair options.

A level survey of the floor was also carried out.

Limitations of Report

Findings presented as part of this report are for the sole use of our client, the Methodist Church and their consultants to assist with insurance assessments on this building. 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 Durham Street Methodist Church Hall building has been damaged, in some areas substantially, as a result of the recent Darfield earthquake and aftershocks.

Building damage includes cracking to the stone side walls and gables. The top section of the east side wall has collapsed.

Collapsed and dislodged stone work will require re-laying. Cracked mortar joints will require deep rake out of the mortar and re-pointing.

Cracking has occurred to the existing lath and plaster ceiling which will require replacement or overlaying with GIB.

The west wall has displaced out by about 80mm and will require substantial repair work or reconstruction.

No ground liquefaction or gross settlement of the building was observed.

The building has been assessed as having a longitudinal (along the building) strength of 16% current code, and a transverse (across the building) strength of 17% current code.

Strengthening in the form of insitu concrete skin walls will increase the longitudinal strength to 33% and 67% depending on the extent of the new walls.

Strengthening work will require grouted tie rods to be installed to the stone walls, to stabilise the walls.

Connections between the gable end walls and the roof structure will be required to secure the gables in place.

Building Form

The Church is located in Durham Street, in the Central Business District of Christchurch city and was constructed in 1864. The Hall was constructed ten years later in 1874.

The complex consists of three main areas, the main Church auditorium, the Annex located at the western end of the auditorium and the hall located at the south-west corner of the site. This report is specifically for the hall.

The hall measures approximately 20m x 11m in plan.

The hall is generally constructed with stone walls, consisting of a natural stone exterior, a plastered stone interior with rubble filled cavity.

A concrete wall is present on the inside face of the two side walls, extending to a height of 1250mm.

The slate roof is likely to be supported on battens with diagonal timber sarking on purlins spanning between the main supporting exposed timber trusses. The ceiling is constructed of lath and plaster. The ground floor is timber and is likely to consist of timber flooring boards on joists supported on timber bearers on concrete or timber piles.

A gallery floor has been constructed at the north end of the hall.


wall construction viewed from inside


damaged entry roof & collapsed east wall


damaged ceiling & bulkhead


damaged bulkhead

Building Condition & Earthquake Damage

The building appears to have been in reasonable condition prior to the earthquake. The mortar used to construct the masonry has been tested using the standard punch test and is considered to be soft lime mortar. At some stage during the life of the building the external mortar joints have been re-pointed with what appears to be a stronger cement based mortar.

The foundations appeared to be in sound condition with few cracks observed and no evidence of significant settlement occurring.

Following the recent earthquake in Darfield, extensive damage has occurred to the building. The following is a summary of the areas and types of damage that has occurred:

- Significant damage has occurred to the upper section of the east wall where part of this wall at roof level has collapsed out.
- The ceilings have been damaged, with damage ranging from cracked lath and plaster throughout most of the hall to partial collapse of coved ceilings near the side walls.
- Cracking of stonework and spalling of plaster to side walls adjacent to the roof truss connections.
- Damaged slate roof and gutters to the two east side foyers, where the adjacent upper section of wall has collapsed.
- The west wall has displaced outwards with a permanent lean of about 80mm at the top. Two substantial cracks are present full length of the wall, one located near the top of the wall, and the other located about 1250mm above the floor and gutters.
- A number of cracks are present in the plaster surfaces inside the hall, particularly around the windows and doors, and in the corners of the walls adjacent to the gable ends.
- A crack has occurred in the wall in the south-west corner where the gable and side wall have started to separate.
- A horizontal crack has formed along both side walls, 1250mm above the floor, at the junction of the low height concrete wall and the natural stone wall above.
- Some buttress stones to the east side have been displaced, with cracked mortar joints.
- The lath and plaster bulkhead to both side walls has been substantially damaged.


crack along west wall


horizontal crack east wall 1250mm above floor


Displaced stones to east wall buttress

- A level survey of the floor indicates the floor is generally within ±10mm of a central datum with a small area of the north end is up to 25mm out of level. It is possible that this is historical and the floor at this location has settled over time.

A summary of the extent of damage is outlined in the attached sketches.

Seismic Assessment

A seismic assessment of the building has been carried out using AS/NZS 1170.5 to determine the applied loadings to the building. The NZ Society of Earthquake Engineering Guidelines, June 2006, has been used to assess the building capacity.

The building has been assessed as an Importance Level 2 (normal) building.

The assessed strength is based on the undamaged state of the building that would have existed prior to the recent earthquakes, or following the repairs noted in "Seismic Repairs & Strengthening" section (a) below.

Various aspects of the building are assessed to determine load paths to the seismic resisting elements, such as walls and buttresses. The capacities of these elements are also assessed to determine their in-plane shear strength, in-plane flexural strength, and out-of-plane strength when subject to face loads.

Strength of connections between the diaphragms and the resisting elements are also assessed.

The assessed strengths are expressed as a percentage of the full code requirements which is summarised in the table below.

Any item that has no appreciable strength, such as a gable end connection to the roof structure which is only nominally connected, is expressed as having 'nil' strength.

Elements that have less that 33% of current code strength are regarded as being earthquake prone and are highlighted in bold.

Transverse Direction (across building)

Element	Mode	% Code
South gable	shear	53%
	flexure	62%
North gable	shear	**17%**
	flexure	**32%**

Longitudinal Direction (along the building)

Element	Mode	% Code
East side wall	shear	**16%**
	flexure	**14%**
West side wall	shear	72%
	flexure	100%

Other Items

Element	% Code
Face load – side walls	59% (i)
Face load – end gable walls	38% (i)
Gable ties to roof	**nil**
Roof diaphragm (diagonal sarking) - side walls - gable walls	 71% 45%

Note (i): These values allow for two single skin walls at 210mm thickness each, although the thickness of the natural stone is significantly variable.

The results of this assessment indicate that a number of aspects of this building are earthquake prone. Christchurch City Council requirements are that buildings of this nature be strengthened to as close as practicable 67% current code.

Seismic Repairs & Strengthening

(a) Repairs

A number of repairs are required to be carried out to reinstate the building to its pre-earthquake condition.

A summary of the building damage is included in this report, which is also outlined in the relevant sketch.

The costs associated with the repairs will require assessment by a quantity surveyor who will need to visit the site to view the extent of damage.

A general outline of repairs is as follows:

- Reconstruct upper section of east wall with stonework.
- Repair cracks to lath and plaster ceiling or re-line with GIB throughout.
- Repair spalled plaster to side walls around roof truss connections.
- Repair roof truss connections where damaged or displacement has occurred.
- Replace damaged slate roof and gutters to the east side foyer roofs.
- Replace gutter to the east side wall.
- Allow to repair damaged flashing to gable end walls.
- Re-construct the displaced west wall, full length, or alternatively prop roof, remove stonework around truss supports, install jacking frame to exterior of west wall and push wall back into alignment with hydraulic jacking system. Reinstate stonework around trusses and reinstate truss supports.
- Remove plaster around cracked sections of wall, rake out mortar joints to a depth of 60mm and re-point. Re-plaster wall. Allow to carry out same re-pointing work to exterior face.
- Rake out mortar joints to damaged stone buttresses to a depth of 60mm and re-point.
- Mortar used for re-pointing shall be 7.5MPa lime mortar with cement content.
- Remove damaged lath and plaster side wall bulkheads and reinstate.
- Re-level 60m^2 of ground floor.

(b) Strengthening to 33% Code

In addition to the repairs outlined in the previous section, the following strengthening work is required to achieve a seismic strength of 33% current code.

Refer to the attached sketch for details of the required seismic strengthening.

- Fibre reinforced concrete facing to two sections of east wall, and north wall, including D20 vertical galvanised rods grouted into wall.
- Continuous reinforced concrete eaves beam to top of east and west side walls.
- Steel angles to north and south gable walls at roof and ceiling, complete with rose head washers at 1500 centres.
- Steel plates at each purlin joint over trusses.
- Stainless steel wall ties at 600 centres each way drilled and grouted into wall.
- Install new tie rods to three remaining trusses.

(c) Strengthening to 67% Code

In addition to the repairs outlined in section (a), the following strengthening work is required to achieve a seismic strength of 67% current code.

- Fibre reinforced concrete facing to two sections of east wall, and north wall, including D20 vertical galvanised rods grouted into wall.
- Continuous reinforced concrete eaves beam to top of east and west side walls.
- Steel angles to north and south gable walls at roof and ceiling, complete with rose head washers at 1500 centres.
- Steel plates at each purlin joint over trusses.
- Stainless steel wall ties at 600 centres each way drilled and grouted into wall.
- Install new tie rods to three remaining trusses.
- Braceline ceiling diaphragm in lieu of standard GIB ceiling.

Refer to the attached sketch for details of the seismic strengthening required.

A geotech investigation will be required prior to any strengthening work being designed and detailed, to confirm ground conditions.

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

Yours sincerely
Structex Metro Limited

Gary Haverland B.Eng (Hons)(Civil)
Senior Structural Engineer &
Director
MIPENZ; CPEng # 209540

Appendix

1. Building Act Requirements
2. Christchurch City Council Requirements for Earthquake Prone Buildings
3. Sketches

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 unsanitary 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.

2. Christchurch City Council Requirements for Earthquake-Prone Buildings

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

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

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

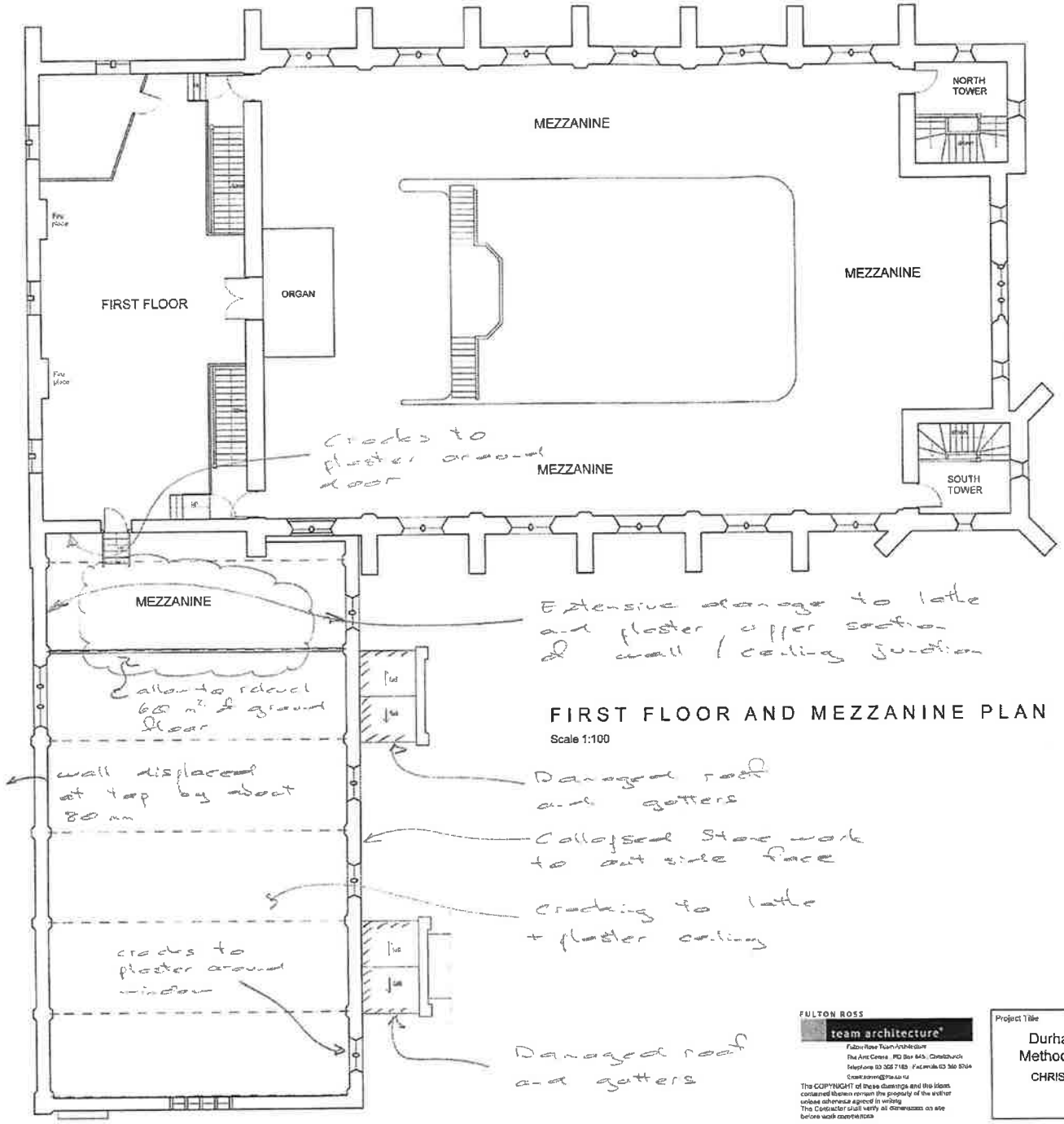
(a) Buildings are assessed using the New Zealand Society of Earthquake Engineering (NZSEE) guidelines with applied loadings from AS/NZS 1170.5 and are classed as earthquake prone if its strength is less than 33% of the applied loading from the loading standard AS/NZS 1170.5.

(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 current Code as the target level for strengthening of earthquake-prone buildings. For buildings with a damaged building strength >33% current Code it is recommended (but not required) that the building also be strengthened to 67% of Code requirements

3. Sketches



FIRST FLOOR AND MEZZANINE PLAN

Scale 1:100

NORTH

Revisions

No	Date	Sheet

structex

Job No: 1071E

Date: 17 Feb 2011

Sketch : Sk 1 A

Damage Summary Hall

Not to Scale

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Fulton Rose Team Architecture
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Project Title: Durham Street Methodist Church, CHRISTCHURCH

Drawing Title: FIRST FLOOR PLAN

Scale: A2 @ 1:100

Drawn by MD Date January 2011

Checked WF Date January 2011

Issue: PRELIMINARY

Date 25th January 2011

Sheet No. A1.2

C.A.D file

Project No 5461 E

Rev

Revisions

No	Date	Subject

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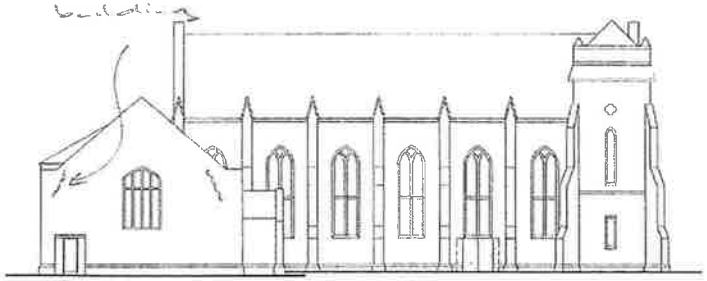
Job No: 10715

Date: 3 Feb 2011

Sketch: sk 2

cracks visible inside face of building



SOUTH ELEVATION

upper section of wall collapsed

Garage

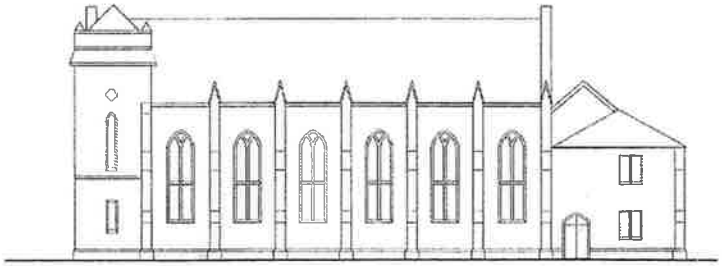
Summary

Hall

EAST ELEVATION

crack to inside face of wall to both sides of building

roof tie connections also damaged.



NORTH ELEVATION

allow to repair flashings

Top of wall also placed out by about 50mm

cracks to wall

WEST ELEVATION

Not to Scale

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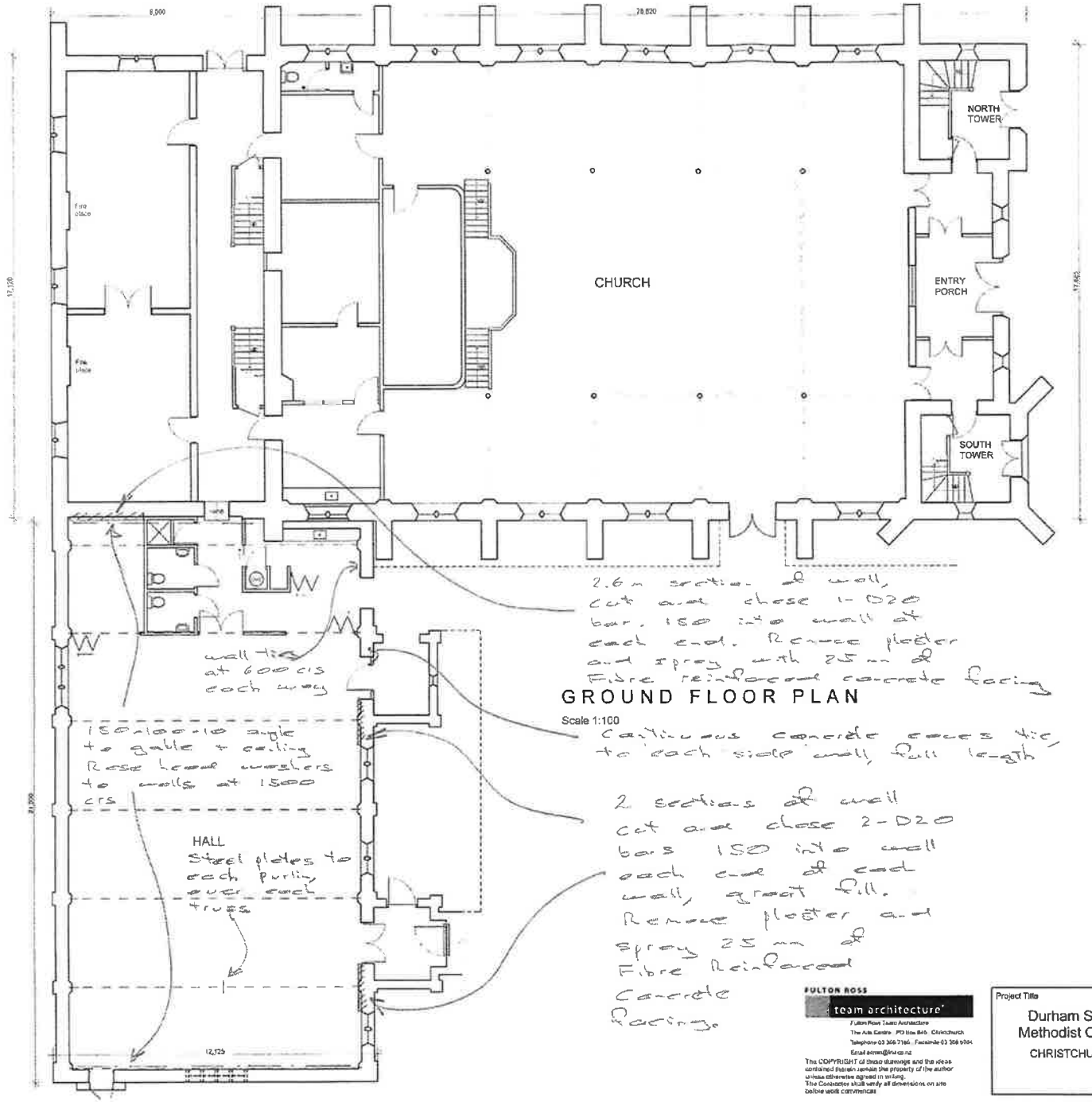
Project Title
Durham Street Methodist Church
CHRISTCHURCH

Drawing Title: ELEVATIONS
scale: A2 @ 1:200

Drawn by	MD	Checked	WF
Date	January 2011	Date	January 2011

Issue: PRELIMINARY

Date	26th January 2011	Sheet No.
C.A.D file		A1.3
Project No.	5461 E	Rev



GROUND FLOOR PLAN

Scale 1:100

NORTH

Revisions

No	Date	Subject

structex

Job No: 10715

Date: 3 Feb 2011

Sketch: SK 3

33% Strengthening

Hall

FULTON ROSS team architecture
Fulton Ross Team Architecture
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Telephone 03 366 7186 Facsimile 03 366 9764
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Project Title
Durham Street Methodist Church
CHRISTCHURCH

Drawing Title: GROUND FLOOR PLAN
scale: A2 @ 1:100
Drawn by: MO
Checked: WF
Date: January 2011
Date: January 2011

Issue: PRELIMINARY
Date: 25th January 2011
Sheet No: A1.1
C A D file
Project No: 5461 E
Rev

Revisions

No	Date	Subject

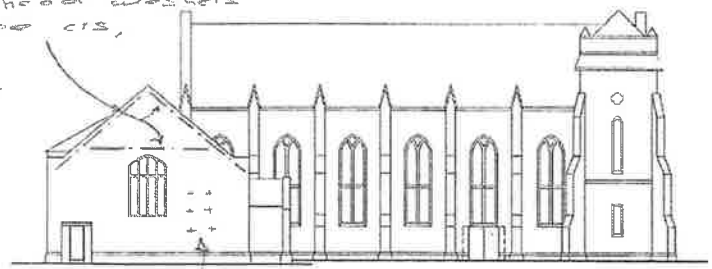
structex

Job No: 10215

Date: 2 Feb 2011

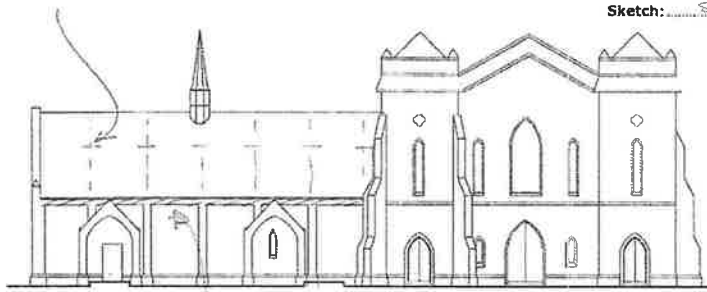
Sketch: Sk 4

150x100x10 angle to gable & ceiling. Rose head washers at 1500 cls, Both gables.



SOUTH ELEVATION

Steel plates to each purlin joint over trusses



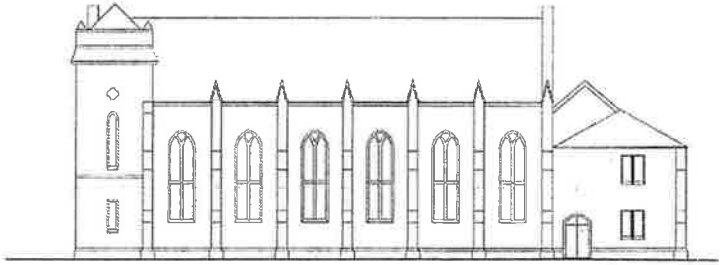
22% Strengthening Hall

(67% Strengthening similar)

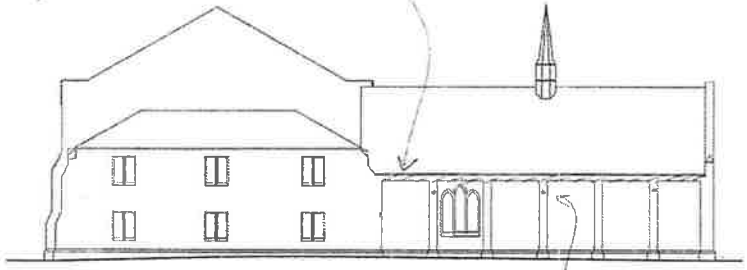
EAST ELEVATION

Stainless steel tie rods in all walls, at 600 cls each way

New continuous concrete tie beam to top of side walls, drill & grout dowels into top of wall



NORTH ELEVATION



Main tie rods to 3 trusses

WEST ELEVATION

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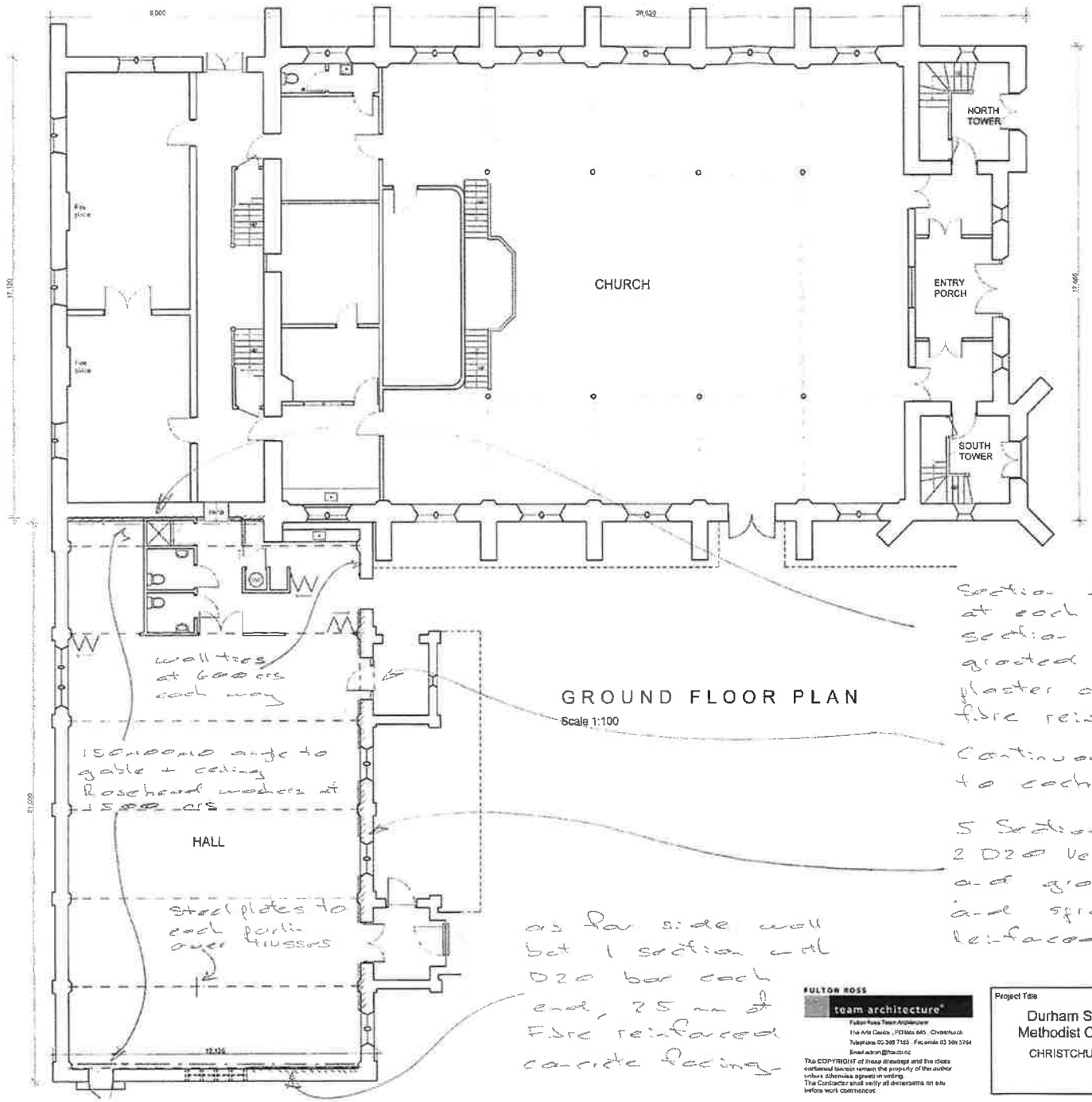
Project Title
Durham Street Methodist Church
CHRISTCHURCH

Drawing Title: ELEVATIONS
Scale: A2 @ 1:200

Drawn by	MD	Checked	WF
Date	January 2011	Date	January 2011

Issue: PRELIMINARY

Date	25th January 2011	Sheet No.
C.A.D file		A1.3
Project No.	5461 E	Rev



GROUND FLOOR PLAN
Scale 1:100

NORTH

Revisions

structex

Job No: 10715
Date: 3 Feb 2011
Sketch : sk 5

67% Strengthening Hall

Section of wall with 4-D20 vertical at each end of each section of wall chased and grouted 150 into wall, Remove plaster and spray with 40mm of fibre reinforced concrete facing

Continuous concrete beam tie to each side wall, full length

5 Sections of wall, cut and chase 2 D20 vertical bars 150 into wall and grout full, Remove plaster and spray 25mm of Fibre reinforced concrete facing

as for side wall but 1 section with D20 bar each end, 75 mm of Fibre reinforced concrete facing

not to scale

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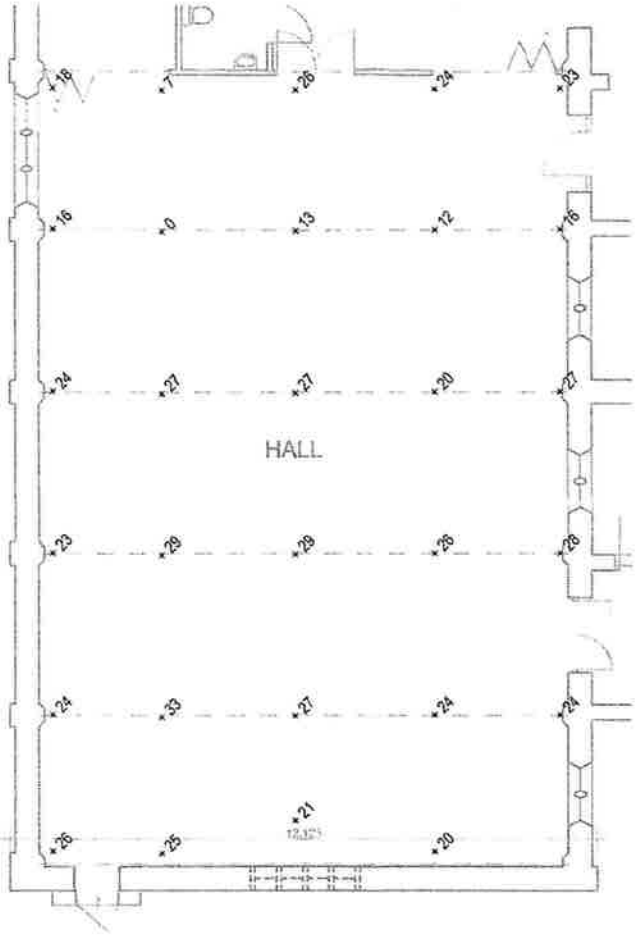
Project Title
Durham Street Methodist Church
CHRISTCHURCH

Drawing Title
GROUND FLOOR PLAN
scale A2 @ 1:100
Drawn by MD Checked WF
Date January 2011 Date January 2011

Issue PRELIMINARY
Date 25th January 2011
C.A.D file
Project No. 5461 E
Sheet No. A1.1
Rev



ground floor part plan - hall

key:

+27 surveyed level

notes:

- all levels are in mm and are relative to the lowest point recorded.
- all levels in the hall were taken to timber flooring

2	FINAL	SP	GH	16-02-11	SP	GH	GH	1:100	ARROW	DURHAM ST METHODIST CHURCH REPAIRS	structex
1	PRELIMINARY	SP	GH	09-02-11							

floor level survey | SK6 | 10715 | 2

structex

Project 10715 – 17 February 2011

Methodist Church & Annex
Durham Street
Christchurch

Structural Assessment & Strengthening Report

Contents

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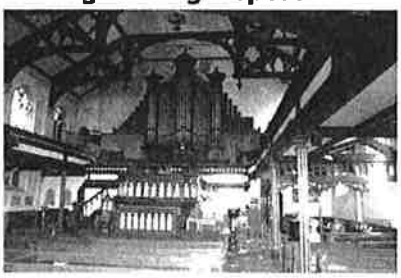
17 February 2011

Tim Fahy
Arrow International Ltd
PO Box 42
Christchurch 8140

Email: tim.fahy@arrowinternational.co.nz

Dear Tim,

Re: Durham Street Methodist Church & Annex
Structural Assessment & Strengthening Report


Introduction

Structex Metro has been engaged to carry out a seismic assessment and report of the existing Durham Street Methodist Church and associated Annex in Christchurch.

The purpose of this report is to summarise the building damage caused by the recent Darfield earthquake on 4 September 2010, and assess the building to determine if it is earthquake prone. If the building is earthquake prone, strengthening options to 33% current code, and 67% current code are provided.

Walk-over surveys of the building were carried out in January 2011. A previous report has been written by Structex dated 4 October 2010 summarising damage and outlining possible repair options.

A level survey of the Auditorium floor was also carried out.

Limitations of Report

Findings presented as part of this report are for the sole use of our client, the Methodist Church and their consultants to assist with insurance assessments on this building. 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 & Recommendations

The Durham Street Methodist Church Hall building has been damaged, in some areas substantially, as a result of the recent Darfield earthquake and aftershocks.

The most substantially damaged areas are the stone towers and eastern wall facing Durham Street, where extensive cracking has occurred to the stone mortar joints, collapsing of the upper sections of the gable, and extensive cracking and spalling of the plaster inside the building. Much of this area would require reconstruction.

Cracking of stone mortar joints and plaster has also occurred to the west gable of the auditorium, side walls and buttresses.

The lath and plaster ceiling is substantially cracked throughout the Auditorium and will require replacement or overlaying with GIB board.

Some permanent displacement has occurred to the timber floor and posts supporting the mezzanine in the auditorium.

The west wall of the Annex has displaced out from the roof and floor structure. Some cracking is also present in mortar joints of the stone walls, with the most significant cracking occurring on the north wall where some displacement of stonework above the door and at the eaves has occurred.

Collapsed and dislodged stone work will require re-laying. Cracked mortar joints will require deep rake out of the mortar and re-pointing.

No ground liquefaction or gross settlement of the building was observed.

The building has been assessed as having a longitudinal (along the building) strength of 15% current code, and a transverse (across the building) strength of 10% current code.

Strengthening in the form of reinforced concrete skin walls to the tower combined with roof bracing and an eaves beam will increase the lateral strength to 33% and 67% depending on the extent of the new walls and bracing.

Strengthening work will require grouted tie rods to be installed to the stone walls, to stabilise the walls.

Connections between the stone walls and the roof structure will be required to secure the tops of the walls in place.

Building Form

The Church is located in Durham Street, in the Central Business District of Christchurch city and was constructed in 1864. An adjacent Hall was constructed ten years later in 1874.

The complex consists of three main areas, the main Church auditorium, the Annex located at the western end of the auditorium and the hall located at the south-west corner of the site. This report is specifically for the Church auditorium and west Annex.

The Auditorium and Annex combined measure approximately 36.6m x 17.7m in plan.

The building is generally constructed with stone walls, consisting of a natural stone exterior, a plastered stone interior with rubble filled cavity.

Two large stone towers are constructed at the east end of the building on the north and south corners.

The slate roof is likely to be supported on battens with timber sarking on purlins spanning between timber trusses. The ceiling to the Auditorium is constructed of lath and plaster. The ceiling above the first floor of the Annex is sheet panelling with battens.

The gallery floor to the Auditorium and the first floor of the west Annex are constructed of timber. Two offices and a corridor are located below the annex first floor.

The ground floor is also timber and is likely to consist of timber flooring boards on joists supported on timber bearers on concrete or timber piles.

Building Condition & Earthquake Damage

The building appears to have been in reasonable condition prior to the earthquake. The mortar used to construct the masonry is likely to be the same as the hall, which has been tested using the standard punch test and is considered to be soft lime mortar. At some stage during the life of the building the external mortar joints have been re-pointed with what appears to be a stronger cement based mortar.

The foundations appeared to be in sound condition with few cracks observed and no evidence of significant settlement occurring.

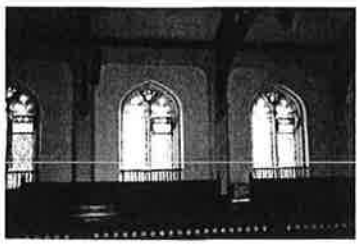
Following the recent earthquake in Darfield, extensive damage has occurred to the building. The following is a summary of the areas and types of damage that has occurred:

cracked & spalling plaster north tower

Annex

- The west wall of the Annex has displaced out from the building with a permanent residual lean of up to 30mm at roof level and up to 10-15mm at first floor.
- Cracked and spalling plaster to both faces of the Auditorium gable wall, west end.
- Extensive cracking with some displacement of stonework to the north wall of the Annex, including loose stones at eaves level.
- Cracked and spalling plaster to the inside face of the Annex, west wall near ceiling and north wall around window.
- Limited cracking to ground floor internal wall between offices.
- Various cracking of plaster and stonework around windows.
- Damaged and displaced truss supports to the west wall.
- Minor cracking of the west wall including displaced exterior stones at eaves level.

cracked lath & plaster ceiling



Auditorium side walls

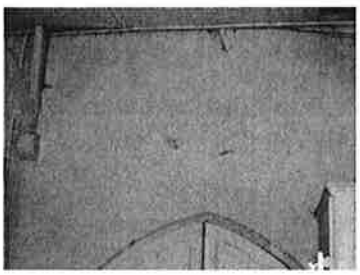
side wall & Tower wall spalling plaster

Auditorium

- Extensive cracking of lath and plaster ceiling, flat portion and coved area, as well as some cracking to the ceiling below the gallery.
- Minor cracking to inside face of side walls, primarily around and near top of arch windows. Cracking is more significant adjacent to the towers.
- Damaged or displaced corbel stones supporting the gallery beams, 7 off.
- Extensive cracking to the stone mortar joints to the north tower and the east gable wall.

dislodged east gable parapet & finial

- Damaged and displaced stone finials to the north tower and east gable.



cracks to back of west wall gable

Annex west wall damaged truss support & displaced wall

Spalling plaster & collapsed corbel at gallery support beams

west wall annex displaced brick

- Extensive cracking and spalling of plaster to the inside face of the north and south towers, as well as the east gable wall.
- Displaced and dislodged stone to the north side wall buttresses.
- Cracking of stone mortar joints to the side wall buttresses. Four of the north wall buttresses have substantial cracking (5-15mm width). The remaining north and south wall buttresses are also cracked, with cracking 2-5mm wide.
- Cracking of some mortar joints to stonework window frames.
- A level survey of the floor shows the floor is constructed with a general fall to the west of about 100mm, however the floor is significantly out of level by up to 50mm. It is most likely that this has occurred over a long period of time with the weight of the side walls and towers having settled during the life of the building.

A summary of the extent of damage is outlined in the attached sketches.

Annex north wall spalling plaster around window

Damaged stone to north tower window

North wall buttress displaced stone

north wall cracked buttresses

Seismic Assessment

A seismic assessment of the building has been carried out using AS/NZS 1170.5 to determine the applied loadings to the building. The NZ Society of Earthquake Engineering Guidelines, June 2006, has been used to assess the building capacity.

As the Auditorium has a seating capacity in excess of 300 people, the building has been assessed as an Importance Level 3 (structures containing people in crowds) building. The design earthquake loads for this building are 30% higher than what a "normal" building is designed to.

The assessed strength is based on the undamaged state of the building that would have existed prior to the recent earthquakes, or following the repairs noted in "Seismic Repairs & Strengthening" section (a) below.

Various aspects of the building are assessed to determine load paths to the seismic resisting elements, such as walls and buttresses. The capacities of these elements are also assessed to determine their in-plane shear strength, in-plane flexural strength, and out-of-plane strength when subject to face loads.

Strength of connections between the diaphragms and the resisting elements are also assessed.

The assessed strengths are expressed as a percentage of the full code requirements which is summarised in the table below.

Any item that has no appreciable strength, such as a gable end connection to the roof structure which is only nominally connected, is expressed as having 'nil' strength.

Elements that have less that 33% of current code strength are regarded as being earthquake prone and are highlighted in bold.

Transverse Direction (across building)

Element	Mode	% Code
West wall Annex	shear	51%
	flexure	59%
West wall Auditorium	shear	61%
	flexure	87%
Auditorium	shear	**12%**
	flexure	**10%**
East Towers	shear	**17%**
	flexure	**17%**

Longitudinal Direction (along the building)

Element	Mode	% Code
North side wall	shear	**17%**
	flexure	**19%**
South side wall	shear	**15%**
	flexure	**20%**

Other Items

Element	% Code
Face load – east end gable wall	**15%** (i)
Face load – side walls	N/A (ii)
Face load - west end gable	**20%** (i)
Face load – Annex walls	52% (i)
Gable ties to roof	**nil**
Roof diaphragm (diagonal sarking) - side walls - gable walls	 **16%** **11%**

Note (i) These values allow for two single skin walls at 210mm thickness each, although the thickness of the natural stone is significantly variable, and are assumed to be restrained at the roof and floors.

(ii) Auditorium side walls are well restrained by the buttresses.

The results of this assessment Indicate that a number of aspects of this building are earthquake prone. Christchurch City Council requirements are that buildings of this nature be strengthened to as close as practicable 67% current code.

Seismic Repairs & Strengthening

(a) Repairs

A number of repairs are required to be carried out to reinstate the building to its pre-earthquake condition.

A summary of the building damage is included in this report, which is also outlined in the relevant sketch.

The costs associated with the repairs will require assessment by a quantity surveyor who will need to visit the site to view the extent of damage.

A general outline of repairs is as follows:

- Re-line ceiling of Auditorium with GIB throughout.
- Repair Annex roof truss connections where damage or displacement has occurred.
- Realign and reinstate damaged and displaced stonework to buttresses.
- Remove damaged plaster around window frames, rake out cracked joints to a depth of 60mm and re-point.
- Reinstate damaged and dislodged corbels supporting the gallery beams, 7 off.
- Allow to remove and reinstate stones that have significantly cracked mortar joints and are displaced to the north wall buttresses, north tower and east gable. This will require reconstruction of some sections of the north wall of the buttresses and the north-east corner of the north tower.
- Reinstate damaged or displaced stone finials to the side wall buttresses and east gable wall.
- Re-level floor.
- Allow to repair damaged flashing to gable end walls.
- Remove plaster around cracked sections of wall, rake out mortar joints to a depth of 60mm and re-point. Re-plaster wall. Allow to carry out same re-pointing work to exterior face.
- Rake out mortar joints to damaged stone buttresses to a depth of 60mm and re-point.
- Mortar used for re-pointing shall be 7.5MPa lime mortar with cement content.
- The most significant area of damage is to the north tower and east gable wall where extensive cracking has occurred to stonework. Extensive cracking and spalling of the plaster to the inside face of the north tower, east gable wall, as well as the south tower has occurred; which will require significant reconstruction. This could be carried out in a number of ways:

  Option one includes carefully demolishing the towers and east gable wall, photographing and recording the layout of the stonework. A new reinforced concrete wall would be constructed to form the inside face and the stonework would be re-laid to the exterior face against the new concrete walls.

  Option two includes bracing the towers and east wall full height complete with tie rods passing through the wall to stabilise both faces of the wall. Displaced or dislodged stone can then be reinstated. The inside face of the wall will then be progressively removed from the top and spray concrete applied to the inside face of the exterior stonework, with tie rods progressively installed.

After the inside face of the stone is fully stripped out and first layer of sprayed concrete applied, a new insitu reinforced concrete skin wall can be constructed to secure the towers and east gable.

In both cases, the concrete walls to the tower and gable provide significant additional strength to the building.

It is likely that option 2 would be used with only the significantly damaged north-east corner of the north tower being totally reconstructed using option one. The internal walls of the tower could be removed completely and reconstructed in concrete.

(b) Strengthening to 33% Code

In addition to the repairs outlined in the previous section, the following strengthening work is required to achieve a seismic strength of 33% current code.

Refer to the attached sketch for details of the required seismic strengthening.

- Continuous reinforced concrete eaves beam to top of north and south side walls.
- Steel angles to east and west gable walls at roof, ceiling and floor level, complete with rose head washers at 1500 centres.
- Steel plates at each purlin joint over trusses, Auditorium and Annex.
- Stainless steel wall ties at 600 centres each way drilled and grouted into wall and buttresses.
- Install new fixings at roof truss locations, bolting right through buttresses complete with rose head washers, Auditorium and Annex.
- Install floor fixings complete with angle brackets and tie and rods each side of gallery floor beams to masonry walls.
- Install continuous steel angle to perimeter of Annex, floor and roof level, complete with angle brackets and threaded rods bolted through the stone walls with rose head washers at 1500 centres.
- New Braceline ceiling diaphragm to the first floor Annex ceiling and steel rod roof bracing to the Auditorium ceiling.

(c) Strengthening to 67% Code

In addition to the repairs outlined in section (a), the following strengthening work is required to achieve a seismic strength of 67% current code.

- Continuous reinforced concrete eaves beam to top of north and south side walls.
- Steel angles to east and west gable walls at roof, ceiling and floor level, complete with rose head washers at 1500 centres.
- Steel plates at each purlin joint over trusses, Auditorium and Annex.
- Stainless steel wall ties at 600 centres each way drilled and grouted into wall and buttresses.
- Install new fixings at roof truss locations, bolting right through buttresses complete with rose head washers, Auditorium and Annex.
- Install floor fixings complete with angle brackets and tie and rods each side of gallery floor beams to masonry walls.
- Install continuous steel angle to perimeter of Annex, floor and roof level, complete with angle brackets and threaded rods bolted through the stone walls with rose head washers at 1500 centres.

- New Braceline ceiling diaphragm to the first floor Annex ceiling and steel rod roof bracing to the Auditorium ceiling.
- New concrete skin walls to the Annex.

Refer to the attached sketch for details of the seismic strengthening required.

A geotech investigation will be required prior to any strengthening work being carried out to confirm ground conditions.

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

Yours sincerely
Structex Metro Limited

Gary Haverland B.Eng (Hons)(Civil)
Senior Structural Engineer &
Director
MIPENZ; CPEng # 209540

Appendix

1. Building Act Requirements
2. Christchurch City Council Requirements for Earthquake Prone Buildings
3. Sketches

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 unsanitary 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.

2. Christchurch City Council Requirements for Earthquake-Prone Buildings

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

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

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

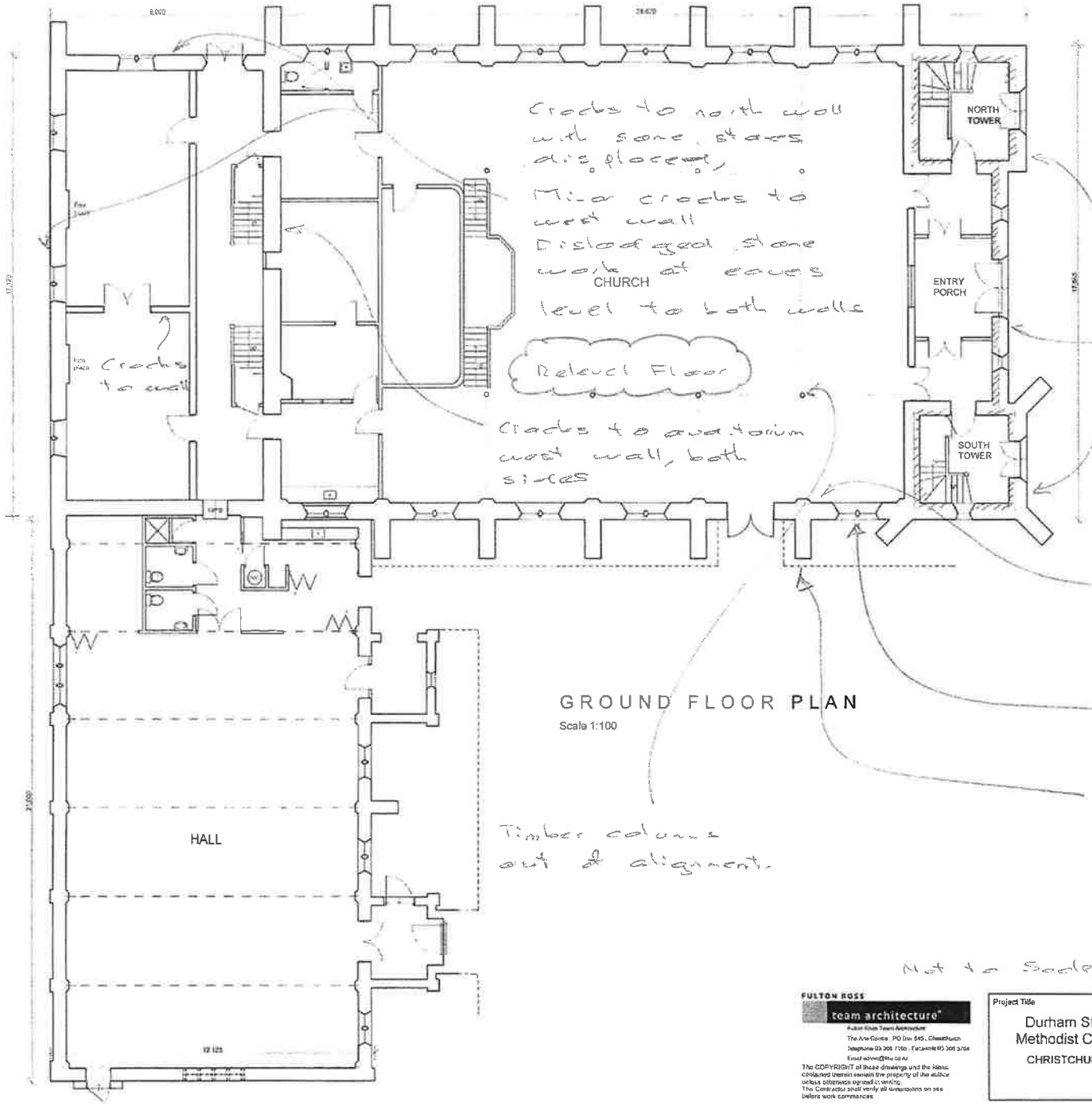
(a) Buildings are assessed using the New Zealand Society of Earthquake Engineering (NZSEE) guidelines with applied loadings from AS/NZS 1170.5 and are classed as earthquake prone if its strength is less than 33% of the applied loading from the loading standard AS/NZS 1170.5.

(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 current Code as the target level for strengthening of earthquake-prone buildings. For buildings with a damaged building strength >33% current Code it is recommended (but not required) that the building also be strengthened to 67% of Code requirements

3. Sketches



GROUND FLOOR PLAN
Scale 1:100

Cracks to north wall with some stones displaced,
Minor cracks to west wall
Dislodged stone work at eaves level to both walls

Cracks to wall

Cracks to auditorium west wall, both sides

Timber columns out of alignment.

NORTH

structex

Job No: 10715
Date: 17 Feb 2011
Sketch: sk 1 rev A

Damage Summary Church

Significant Damage to exterior stone and interior plaster work to towers and east gable wall

Some cracking to side walls mainly around tops of windows

Some stone work to windows displaced

Side wall buttresses have cracks and some displaced stones, 11 buttresses on the north side have significant cracks.

Not to Scale

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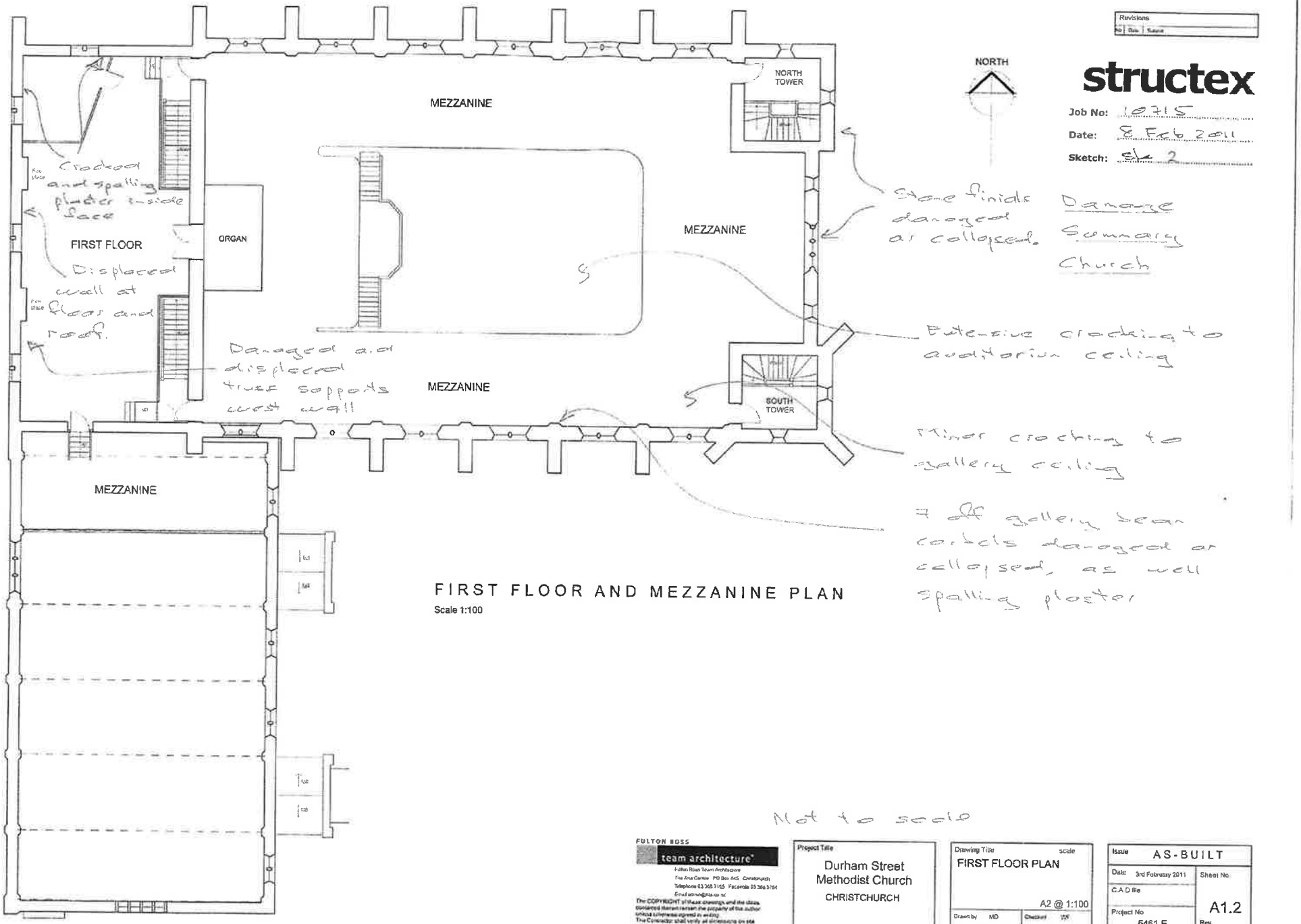
Project Title: Durham Street Methodist Church, CHRISTCHURCH

Drawing Title: GROUND FLOOR PLAN
Scale: A2 @ 1:100
Drawn by: MD
Checked: WF
Date: January 2011
Date: January 2011

Issue: AS-BUILT
Date: 3rd February 2011
Sheet No: A1.1
CAD file:
Project No: 5461 E
Rev:



FIRST FLOOR AND MEZZANINE PLAN

Scale 1:100

Not to scale

structex

Job No: 10715

Date: 8 Feb 2011

Sketch: sk 2

Revisions

No	Date	Issue

FULTON BOSS team architecture

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Project Title: Durham Street Methodist Church, CHRISTCHURCH

Drawing Title: FIRST FLOOR PLAN

scale: A2 @ 1:100

Drawn by: MD Date: January 2011

Checked: WF Date: January 2011

Issue: AS-BUILT

Date: 3rd February 2011

C.A.D file:

Project No: 5461 E

Sheet No: A1.2

Rev:

Revisions

No	Date	Issued

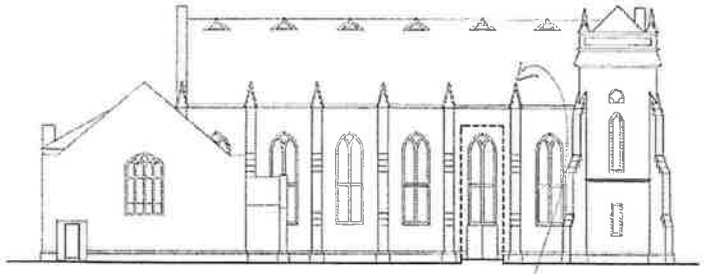
structex

Job No: 10315

Date: 2 Feb 2011

Sketch: Sk 3

Damage Summary Church

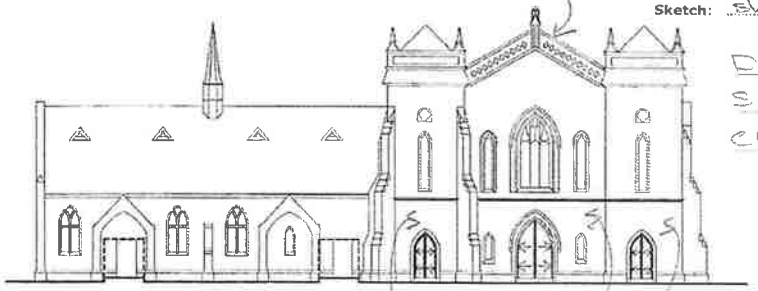


SOUTH ELEVATION

Some stone window sills displaced.

Some buttress stones displaced

Some stone finials displaced

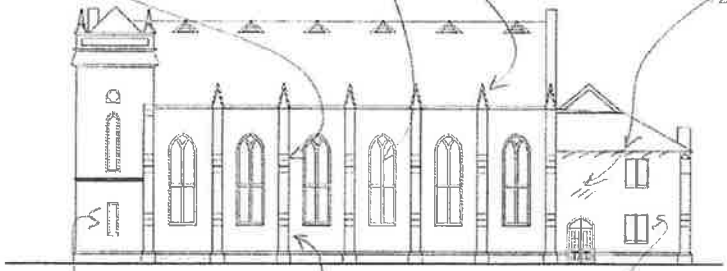


EAST ELEVATION

Stone finials/ parapet displaced + removed.

Minor cracking to exterior south tower

Extensive cracking to exterior north tower and east gable



NORTH ELEVATION

Displaced stone at eaves and above door

Extensive cracking to exterior stone at tower

Large cracks to N walls, wall buttresses. Cracks to remaining buttresses

Extensive cracking

WEST ELEVATION

Minor cracking to stone

Not to scale

FULTON ROSS team architecture

Project Title: Durham Street Methodist Church, CHRISTCHURCH

Drawing Title: ELEVATIONS

Scale: A2 @ 1.200

Drawn by: MD Date: January 2011

Checked: WF Date: January 2011

Issue: AS-BUILT

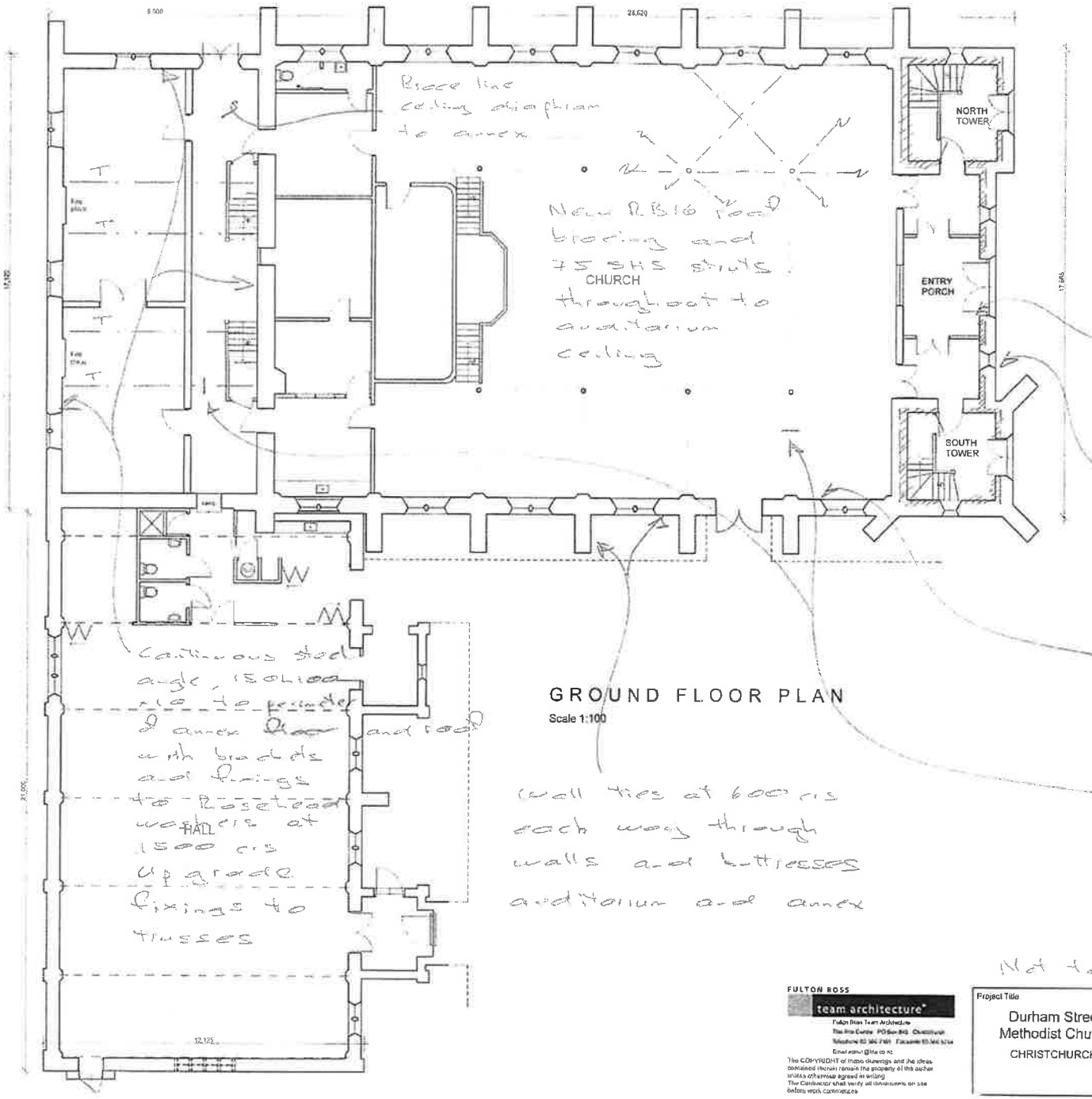
Date: 3rd February 2011

Sheet No.: A1.3

CAD file

Project No: 5461 E

Rev



Revisions

NORTH

structex

Job No: 1461E

Date: 8 Feb 2011

Sketch: Sk 4

33% Strengthening Church

Not to scale

FULTON ROSS team architecture

Project Title: Durham Street Methodist Church, CHRISTCHURCH

Drawing Title: GROUND FLOOR PLAN — scale: A2 @ 1:100

Drawn by: MD — Date: January 2011 — Checked: WF — Date: January 2011

Issue: AS-BUILT

Date: 3rd February 2011

CAD file:

Project No: 5461 E

Sheet No: A1.1

Rev:

Revisions

No | Date | Subject

structex

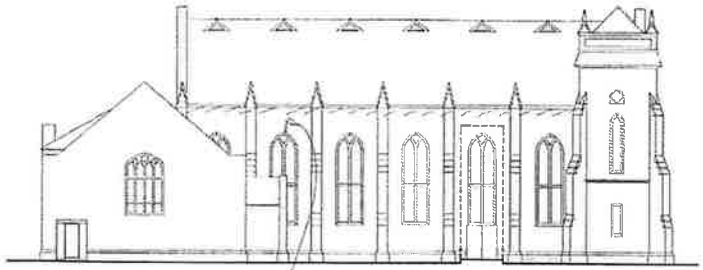
Job No: 5461 E

Date: 16 Feb 2011

Sketch: SL C A

Steel angle tie, 150 x 100 x 10 and Raschead washers at 1500 crs,

33 % Strengthening Church



SOUTH ELEVATION

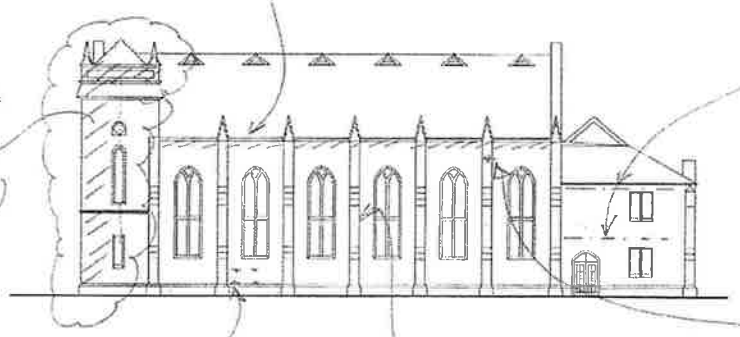
EAST ELEVATION

Reconstruct extensively damaged walls

Continuous concrete tie beam to top of side walls

Steel angle tie and Raschead washers at 1500 crs

Reconstruct extensively damaged walls



NORTH ELEVATION

WEST ELEVATION

Stainless steel tie rods in all walls and buttresses at 600 crs each way

Steel bracket fixing gallery beams to buttresses

New roof truss connections

Not to scale

FULTON ROSS

team architecture

Fulton Ross Team Architecture
The Arts Centre PO Box 541 Christchurch
Telephone 03 366 7165 Facsimile 03 366 8704
Email admin@fta.co.nz

Project Title: Durham Street Methodist Church, CHRISTCHURCH

Drawing Title: ELEVATIONS

Scale: A2 @ 1:200

Drawn by: MD Date: January 2011

Checked: WF Date: January 2011

Issue: AS-BUILT

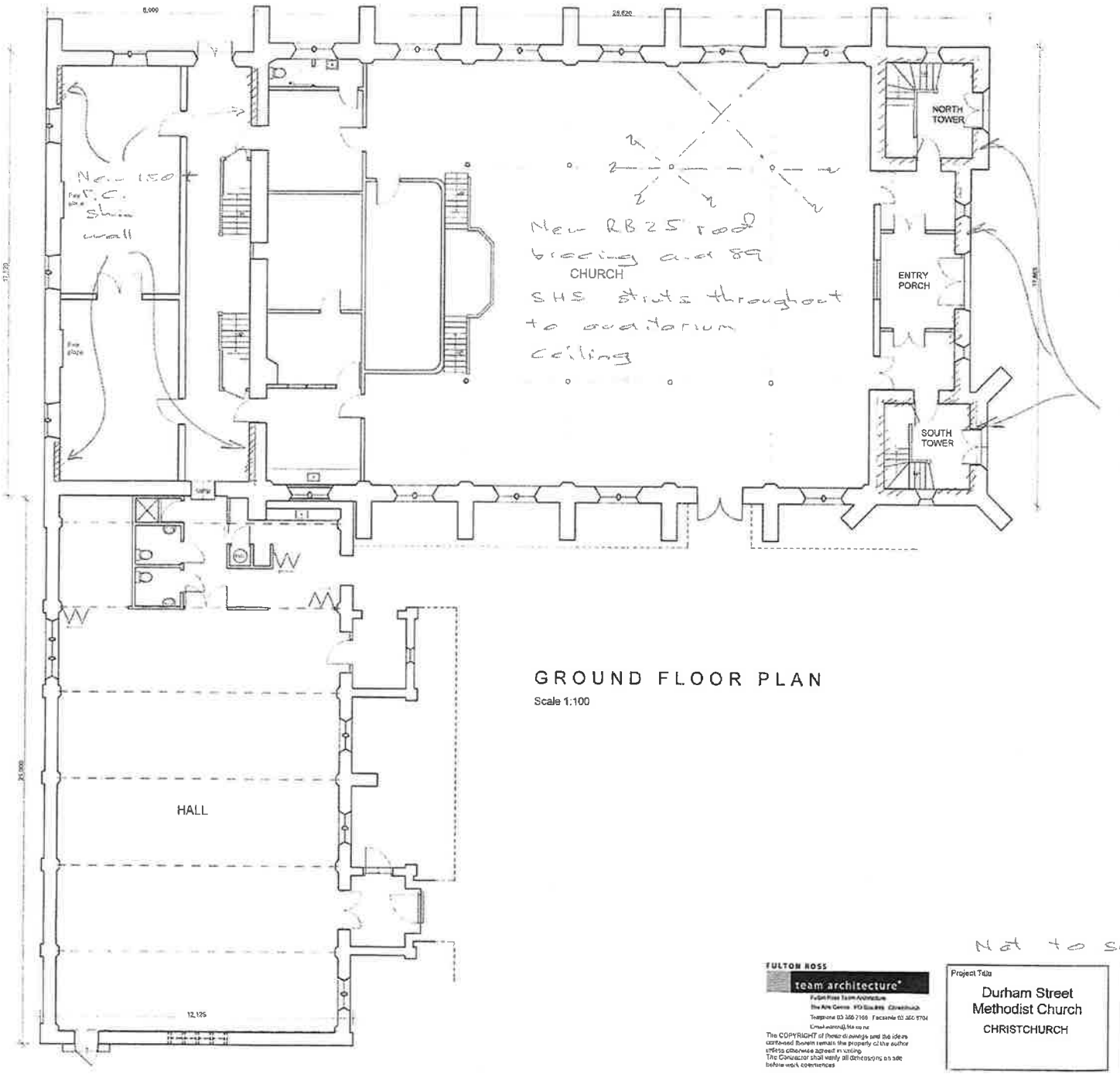
Date: 3rd February 2011

CAD file

Sheet No: A1.3

Project No: 5461 E

Rev



GROUND FLOOR PLAN

Scale 1:100

Not to scale

Revisions

Rev	Date	Subject

NORTH

structex

Job No: 10715

Date: 8 Feb 2011

Sketch: sk 6

FULTON ROSS team architecture
Fulton Ross Team Architecture
The Arts Centre PO Box 846 Christchurch
Telephone 03 366 7166 Facsimile 03 366 9704
Email admin@frta.co.nz

Project Title: Durham Street Methodist Church, CHRISTCHURCH

Drawing Title: GROUND FLOOR PLAN

Scale: A2 @ 1:100

Drawn by: MD Date: January 2011

Checked: MF Date: January 2011

Issue: AS-BUILT

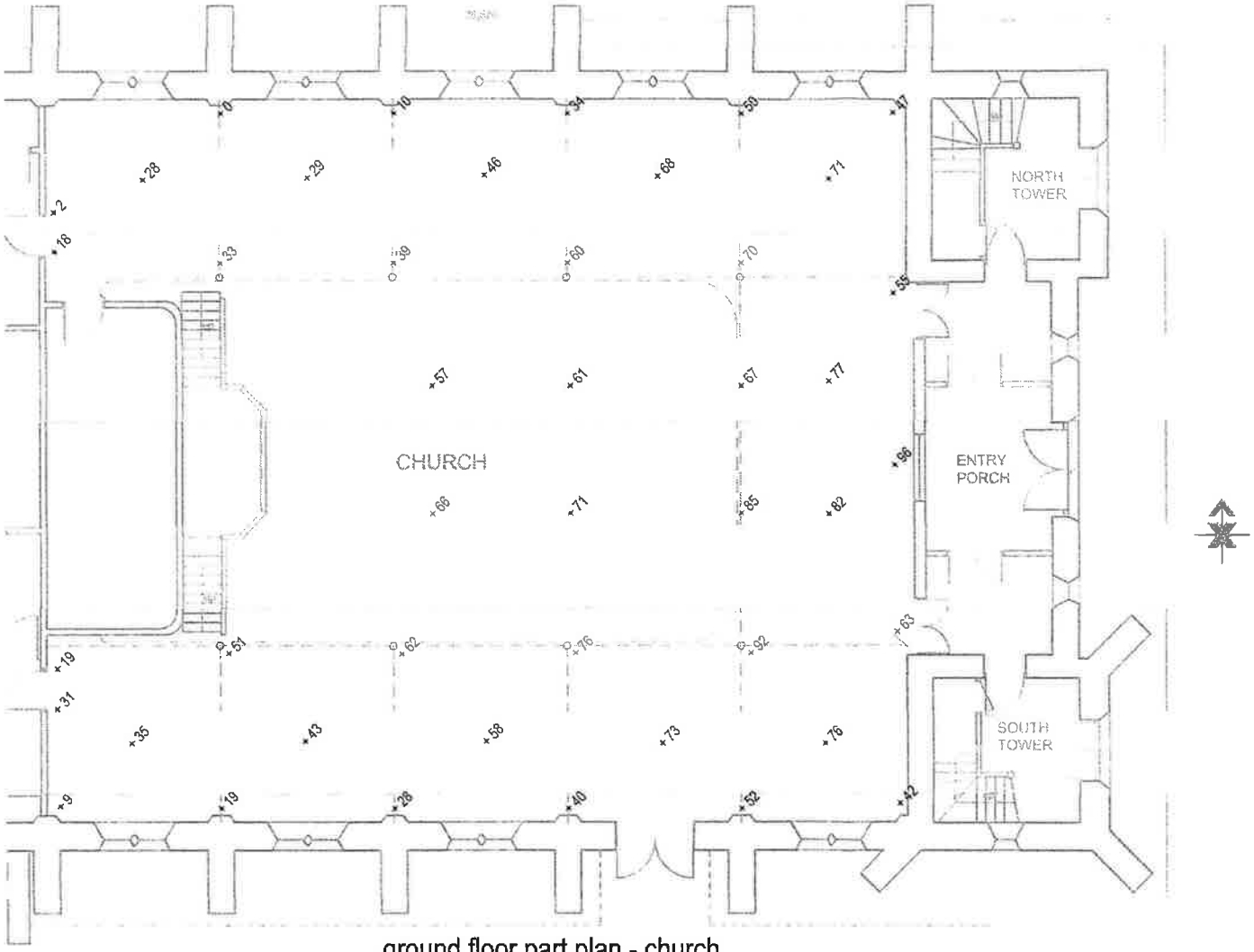
Date: 3rd February 2011

Sheet No: A1.1

C.A.D file:

Project No: 5461 E

Rev:



ground floor part plan - church

key:

+27 surveyed level

notes:

- all levels are in mm and are relative to the lowest point recorded.
- all levels in the church were taken on carpet, allow +/- 2mm tolerance

2	FINAL	SP	GH	16-02-11	SP	GH	GH	1:100	ARROW	DURHAM ST METHODIST CHURCH REPAIRS	structex	floor level survey	SK7	10715 2
1	PRELIMINARY	SP	GH	09-02-11										