

**INDEPENDENT ASSESSMENT ON EARTHQUAKE PERFORMANCE
OF
7 Riccarton Road**

**FOR
Royal Commission of Inquiry into building failure
caused by the Canterbury Earthquakes**

**Report prepared by Peter C Smith and Jonathan W Devine
OF
Spencer Holmes Ltd**

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Introduction

This report has been commissioned by the Royal Commission of Inquiry into building failure caused by the Canterbury Earthquakes to review the performance of the building at 7 Riccarton Road, Christchurch, in which St Christopher's Church Second Hand Bookshop was a tenant, during the Canterbury earthquake sequence.

The report is based on documentation provided by the Royal Commission of Inquiry into building failure caused by the Canterbury Earthquakes. No inspection of the building was possible prior to demolition.

Location of Building

The building at 7 Riccarton Road was located on the southern side of Riccarton Road between Deans Avenue and Bartlett Street. The site is located outside the Christchurch CBD and is identified on the site plan in Appendix 1.

Description of Building

The building at 7 Riccarton Road was an isolated two storey un-reinforced masonry building constructed with timber roof framing and a timber first floor. The building had a relatively high parapet along the street frontage which returned around the side walls. The parapet reduced in height along the side walls. A lean-to extension was constructed along the eastern side of the original building.

The building had a very open ground floor façade and significant openings in the first floor façade to Riccarton Road. The return walls had fewer penetrations.

Compliance

Christchurch City Council records in respect of the property at 7 Riccarton Road are minimal. We sighted no documentation in respect of a concrete frame that is known to have been constructed along the street frontage of the lower floor.

Inspection of the photos taken after the 22nd February, 2011 earthquake show all interior first floor wall and ceiling linings had been stripped out before the earthquake. We have sighted no records from the Christchurch City Council that explain the removal of all wall and ceiling linings to the first floor. We assume that the owner had commenced alteration of the first floor space without consent.

Christchurch City Council policy on Earthquake Prone Buildings

We understand that the Christchurch City Council applied and was granted powers under the Section 301A of the Municipal Corporations Act and that prior to the introduction of the Building Act 2004, the Christchurch City Council adopted a passive approach to the upgrading of earthquake risk buildings.

There was a Seismic Risk Building-Survey of the property undertaken by the Christchurch City Council on 18th February, 1991. The Seismic Risk Building-Survey form records that the building had 1.5 to 2 metre high brick parapets. The assessment recorded cracking of the parapet and that the parapets were in poor condition. The assessment also noted alterations to the ground floor involving the addition of a concrete frame across the shop front. The building was assessed under the Seismic Risk Building-Survey with a numerical rating of 13, providing the building with a building classification B requiring upgrading within 2 years. Photos appended to the assessment clearly show cracking of the front façade and of the return walls towards the rear of the building. A Hazardous Appendage Survey dated 15 February, 1993 identified a 1.2m cracked parapet and a 200mm overhanging cornice.

The Christchurch City Council's first policy in respect of earthquake-prone, dangerous and insanitary buildings policy was introduced in 2006.

This policy was reviewed in early 2010.

Events Subsequent to 4th September 2010 Earthquake

A Rapid Assessment-Level 1 was undertaken for the Council by Nigel Harwood, a CPEng registered civil engineer on 6th September, 2010. The building was assigned a green placard. The assessment recorded only minor or no damage to the building as a result of the 4th September, 2010 earthquake and assigned the building a green placard.

A Rapid Assessment-Level 2 was undertaken by David Elliott, of Aurecon, on behalf of the tenant, on 7th September, 2010. The Rapid Assessment-Level 2 noted moderate wall or other structural damage commenting "Cracks above window lintels and near parapets. Currently stable". This assessment assigned the building a green placard.(G1). The assessment commented "Over 100yr old brick building. Walk around exterior and interior. Cracks to internal areas and near parapets. No major tear or distortion. Building in very poor state of repair prior to earthquake".

Mr Elliott again inspected the premises and undertook a further Rapid Assessment-Level 2 on 9th September, 2010. The assessment notes "Second visit following more aftershocks. Only outside reviewed. No change to assessment made." The assessment noted "checked front parapet and west wall. Could not observe much change. Parapets still looks vertical and stable".

In a letter to the tenants, Mr Elliott stated: "negligible observable structural damage" and assessed as "occupiable" for its continuing use as a commercial premise". He recorded brick cracking over windows of the north façade. The letter included a recommendation that strengthening of the building be carried out. This assessment was undertaken for St Christophers Church.

Council files include a Rapid Assessment-Level 1 undertaken on 11th September, 2010 by Russell Officer. The assessment notes "Large crack in front façade + parapet. Engineer to inspect and advise. Restricted access for inspection only". The Rapid Assessment assigned the property a yellow placard and assessed the estimated overall building damage at 0 to 1%. The assessment also recommended a Rapid Assessment-Level 2 detailed engineering evaluation of the property.

On 30th September, 2010 the Christchurch City Council records, presumably based on the latest Rapid Assessment-Level 1, noted the need for “certification from CPEng that building is not dangerous etc. Send attached certification requirements and copy of Section 121 as email to owner’s PA.” The form was completed by Laura Bronner and recorded that the Engineer had been advised by email. A subsequent Christchurch City Council Enforcement Team Updated Information Sheet recorded “Before Council agrees building is acceptable for occupancy, Council requires certification as per standard requirements. Advise owner of same”. This was also recorded as being forwarded to the engineer by email and the form was completed by Maree Redmond. The email was forwarded to Mr Elliott at Aurecon on 4th October, 2010.

On 19th October, 2010 a Rapid Assessment-Level 2 was undertaken by Ross Kain. The assessment noted “Cracking in parapet to be checked by engineer.” The building was assigned a yellow Y2 placard.

On 19th October, 2010 the Christchurch City Council Notices Coversheet recorded ‘Bookshop closed, letter to owner for confirmation of Engineer inspection. Any remedial works required to be carried out ASAP’ The form noted that “Weakened and cracked walls to be made good and strengthened. Building Consent required and will need CPEng certification”. Laura Bronner forwarded a request to David Elliott of Aurecon on 26th October, 2010 together with the Christchurch City Council standard requirements in respect of upgrading placards on buildings.

On 26th October, 2010 David Elliott responded to Laura Bronner clarifying that in signing off the building, he was advising that no securing work had been carried out to the building. David Elliott commented that the building had not, at his last inspection, sustained any significant structural damage that required repairs prior to occupation. David Elliott forwarded a modified standard Christchurch City Council statement by a Chartered Professional Engineer in respect of the building at 7 Riccarton Road on the 3rd November, 2010.

On 8th November, 2010 the Christchurch City Council record that the David Elliott certification was accepted and that “The building is now considered safe for occupancy. Council advised that the owner could remove any placard that is posted on the building”. There appears to be no record of a Rapid Assessment being undertaken of the building at 7 Riccarton Road following the 26th December, 2010 earthquake.

Mr Yan, arranged for Mr ling to inspect the building following the 26th December, 2010 earthquake. Mr Yan has advised that during an inspection on the 7th January, 2011, they did not see any new damage. Mr Yan advises that Mr Ling had advised him to remove the lathe and plaster wall and ceiling linings in preparation for earthquake strengthening work.

The building at 7 Riccarton Road suffered a substantial collapse of the first floor façade to the north wall and the northern portion of the west wall as well as portions of the east wall following the 22nd February, 2011 earthquake. The building also suffered a collapse of the verandah on the Riccarton Road frontage. The building was assigned a red placard. Fencing was put around the shop front to the full extent of the footpath, kerbing, cones on road to provide temporary footpath. The building was approved for demolition on the 15th April, 2011. A Heritage Building Treatment Report prepared by the Christchurch City Council assessed the building as beyond repair.

Structural Failure

The cracking present in the façade of the building at 7 Riccarton Road reflects the development of a failure mechanism involving the outward movement of the central portion of the façade. The outward failure of the central portion of the façade is restrained by arch action between the piers at the north-east and north-west corners of the façade. For the mechanism to develop further would require an in plane failure of the façade at the north-east and/or north-west corners of the building. We did not observe cracking of the façade at first floor level at either side of the façade in the photos of the façade following the 4th September, 2010 earthquake. We did observe a crack immediately behind the ornamentation at the north end of the west wall to the front façade in photos taken after the 4th September, 2010 earthquake (Refer Appendix 3). The crack appears aged and to relate to a potential front parapet failure. From the photos, the crack does not appear to extend below parapet level. It is unknown the extent to which the cracking was developed on the west side prior to the 4th September, 2010 earthquake. Photos of the east wall after the 22nd February, 2011 earthquake show that the failure at the north end of the east wall is located approx 800mm back from the front of the northern façade. The failure interface on the east wall appears fresh, indicating that no significant crack existed immediately prior to the 22nd February, 2011 earthquake. We consider it likely that the failure mechanism in the 22nd February, 2011 earthquake was an outward rotation of the entire Riccarton Road façade about its first floor support, primarily due to inadequate restraint at roof level.

The code lateral load coefficient for a façade to an elastic responding structure in Christchurch at the time of the earthquake sequence was 0.8g. The analysis of un-reinforced masonry construction is not covered in the NZ Building Code. The industry uses the New Zealand Society for Earthquake Engineering guidelines 'Assessment and Improvement of the Structural Performance of Buildings in Earthquakes' 2000 and Assessment and Improvements of Un-reinforced Masonry Buildings for Earthquake Resistance' 2011. Calculations using these documents indicate that a sound 225mm thick un-reinforced masonry wall spanning 3m from first floor level to roof level and effectively restrained at roof level would meet code requirements. Based on GNS Science records of measurements of accelerations in the Christchurch CBD during the 22nd February, 2011 earthquake, the building is likely to have been subjected to a ground accelerations of 0.9g. This level of ground acceleration equates to an acceleration of 1.25g at first floor level. The analysis assumes no vertical acceleration occurs when the wall is subjected to the horizontal acceleration. The street facade had significant penetrations which affected both the weight and strength of the façade. The above figures demonstrate that the facade may not have survived the Canterbury earthquake sequence had the façade been adequately secured at roof level.

In a poorly secured condition, failure of the wall was almost inevitable in the severity of shaking experienced in the 22nd February, 2010 earthquake.

Issues Arising from Review

Compliance

Inspection of the photographs taken of the building following the 22nd February, 2011 earthquake clearly identifies that the internal wall and ceiling linings to the first floor of the building had been removed prior to the earthquake. Neither of the Rapid Assessment-Level 2's referred to the removal of the linings. Mr Yan advises that the wall and ceiling linings were lathe and plaster and that they were removed after the 26th December, 2010 earthquake on advice from Mr Ling.

The removal of the internal linings was an alteration and should have been undertaken under a building consent.

Removal of the linings will have resulted in some loss of strength and stiffness to the internal partitions and ceiling diaphragm. We are of the opinion that the connection of the wall and ceiling linings, prior to the removal of the linings would not have been sufficient to prevent the outward failure of the façade which we consider was inevitable under the directionality and intensity of shaking which occurred during the earthquake on 22nd February, 2011.

Variability of Rapid Assessments undertaken on building

There is conflict between the rapid assessments undertaken on the building following the 4th September 2010 earthquake. In particular the interpretation of the cracks in the front parapet varied considerably between the rapid assessments undertaken on the buildings

Mr Nigel Harwood, who is a CPEng engineer, undertook a Rapid Assessment-Level 1 of the building on the 6th September, 2010 and assigned the building a green placard. (He has subsequently commented "A green card does not mean that the building is safe. It means that no apparent structural or other safety hazards have been found. The green card encourages owners to "obtain a detailed structural engineering assessment of the building as soon as possible". It also advises that "subsequent events causing damage may change the assessment").

An inspection was undertaken by Mr David Elliott acting on behalf of the tenant. Mr Elliott is a CPEng registered engineer employed by Aurecon in Christchurch. Mr Elliott undertook a Rapid Assessment-Level 1 inspection of the building on the 7th September, 2010 and assigned the building a green placard. Mr Elliott did a Rapid Assessment-Level 2 on the 9th September, 2010 and confirmed the green placard.

A further Rapid Assessment-Level 2 was undertaken by Russell Officer on 11th September, 2010. Mr Officer is currently employed by Fletcher Construction as a contract supervisor and was engaged as a building inspector by the Christchurch City Council from April 2008 to October 2011. Mr Officer inspected the building as a member of a response team including a CPEng engineer, Vaughan McMillen, a search and rescue expert and a safety officer. Mr Officer and his group inspected the building following a call to the Emergency Response Centre on Saturday 11th September, 2010. Mr officer has subsequently commented "There were large cracks above each window on the first floor, that continued up to the top of the parapet. However my main concern was the large cracks at each end of the parapet on the east and west ends of the building. The cracks started from the front facade of the building approximately 1.5m down from the top of the parapet and continued at a 45 degree angle to the top of the parapet, approximately 1.0m from the front façade."

"I came to the conclusion that bracing of the parapet and structural integrity was compromised, and posed a serious risk to both occupants of the building, and members of the public, using the footpath at the northern end of the building. My recommendation to the Rapid Response Team was to issue a red Building Act Section 126 notice, therefore deeming the building unsafe and not to be occupied.

This matter was discussed at length, however, I was instructed to give limited access to the building, for the undertaking of a complete assessment only. (Level 2). I completed the Rapid

Assessment Form Level 1, and a yellow Building Act Section 126 Notice was affixed on the said building.

I was not completely satisfied with the assessment and felt that a red notice should have been issued deeming the building unsafe.”

A further assessment was undertaken by Ross Kain on 30th November, 2010. Mr Kain was employed as a building control officer at the Marlborough District Council and was seconded to the Christchurch City Council for 1 week. Mr Kain inspected the building with Paul Guile, a work colleague from the Marlborough District Council. Paul Guile was also a building control officer. No engineer was present during the inspection. Mr Kain has subsequently advised that “This inspection was primarily carried out to assess whether further damage had occurred since the first inspection. The inspection was also to assess whether any repair work had been carried out on the building. The building was closed and therefore a visual external inspection of the building was undertaken. The building was already yellow stickered. As the building did not appear to be in danger of imminent collapse it was decided by Paul and I that the yellow sticker should remain. I do not remember this building especially. It was known that a previous Rapid Assessment had been carried out but I cannot be absolutely certain that the documentation for this was on site at the time of this inspection as occasionally previous files could not be located. As stated in question 3, this was a follow-up to the first inspection to check whether any repairs had been done and to do a further visual inspection”. Mr Kain advised that he was not undertaking an engineers inspection as he did not hold that qualification, he was undertaking a Level 2 Rapid Inspection.

In 1991, the Christchurch City Council identified cracks in the parapet and side walls to the building when it undertook a Seismic Risk Buildings Survey. Photographs of the building were included with a Hazardous Appendage Survey in 1993, clearly identifying that the majority of the cracks existed in the front parapet to the buildings at that time. (Refer Appendix 2).

Review of the photos taken by Mr Elliott on 7th September, 2010 indicates that there had been some additional cracking as a result of the 4th September, 2010 earthquake. (Refer Appendix 3). Given the extent of cracking evident in the 1993 photos, some extension of these cracks would be expected in the severity of shaking that occurred in the 4th September, 2010 earthquake. David Elliott has also commented that “During my inspection of the building, cracks in the brick walls were noted. Owing to the age of the building, I discussed the condition with Mr North who had been an occupier of the building for some time and appeared quite familiar with the condition of the building. He informed me that the cracks were pre-existing. This was also substantiated in my mind, when I observed that the cracks had mould within the joint and the edges of the cracks had fretted away at the corners of the crack interface due to weathering.”

It is evident that cracks in the front façade did exist prior to the 4th September, 2010 earthquake and that these cracks were likely to have been extended by the earthquake. There is less certainty in relation to the crack behind the parapet on the east wall.

We are of the opinion that the difference in opinion over the severity of damage is due to the CPEng engineers assessing the extent to which the building had been damaged by the recent earthquake while the building inspectors (and Mr McMillan, CPEng engineer, on 11/9/10) were assessing the risk of the building being damaged in a subsequent earthquake.

Basis of Rapid Assessments

As discussed above, the Rapid Assessment process focuses on damage caused to the building by the recent earthquake and the process assumes that the risk that existed before the earthquake was acceptable in the period following the earthquake, subject to limited damage to the building. Historically, aftershocks have caused lesser levels of shaking than the initial earthquake. The Canterbury sequence of earthquakes has tragically identified the potential for an aftershock with an epicentre closer to a developed area to subject that area to more severe shaking than the initial earthquake. The 22nd February, 2011 earthquake raises concern over damage being an appropriate basis for assessment of risk for un-reinforced masonry buildings following a significant earthquake.

It is suggested that after a significant earthquake, territorial authorities brief the assessors on the level of aftershock to be expected and require more comprehensive engineering assessments of un-strengthened un-reinforced masonry buildings prior to allowing public access into the building or the potential fall zone of any building façade or other perceived danger.

It is also suggested that the road frontage of unreinforced masonry buildings be barriered to beyond the fall zone of any façade or fall hazard until the building is assessed.

Security of facades

Tragically the Canterbury earthquake sequence has highlighted the danger to the public of inadequately restrained street facades to many un-reinforced masonry buildings. In the absence of strengthening, the failure of many street facades of un-reinforced masonry buildings was almost inevitable given the severity of shaking that occurred on 22nd February, 2011.

In the interests of public safety, there is a need to adequately secure the upper level walls of un-reinforced masonry buildings, particularly the facades of buildings which present a fall hazard over public spaces or adjoining buildings. These buildings pose a serious risk to the public and those that work in or near the building in the event of a significant earthquake.

Consideration should be given to territorial authorities prioritising the strengthening and upgrading of un-reinforced masonry parapets, facades and other elements that have the potential to cause loss of life in public spaces or adjoining buildings in a significant earthquake.

Upgrading of un-reinforced masonry buildings

The building at 7 Riccarton Road had remained in a relatively original condition up until the recent earthquakes. The damage that occurred to the building in the 22nd February, 2011 earthquake highlights the risk that un-reinforced masonry buildings poses to the occupiers of the building and people in the vicinity of the building at the time of such an event.

The Building Act provides two opportunities for the structural upgrading of buildings. These opportunities are:

- upon a change of use
- implementation and enforcement of an earthquake prone building policy

Improved public safety in a significant earthquake requires territorial authorities to adopt and implement a meaningful programme for strengthening and upgrading of un-reinforced masonry buildings and to enforce the provisions for structural upgrading when a building is subject to a change of use.

Records show that the Christchurch City Council were aware of the earthquake prone condition of the building in 1991. While the delay in the Christchurch City Council implementing a policy on earthquake prone buildings may or may not have contributed to the damage which occurred as a result of the severe shaking that occurred in the 22nd February, 2011 earthquake, it is unfortunate that the Christchurch City Council did not require building owners to remove or secure parapets to buildings along street frontages and/or creating a fall hazard on adjoining buildings.

Undoubtedly the Christchurch City Council's attitude to earthquake risk buildings was influenced by the perception that Christchurch was a low seismic hazard zone.

Report Prepared By:-

Peter C Smith
BE, FIPENZ, CPEng IntPE
Director

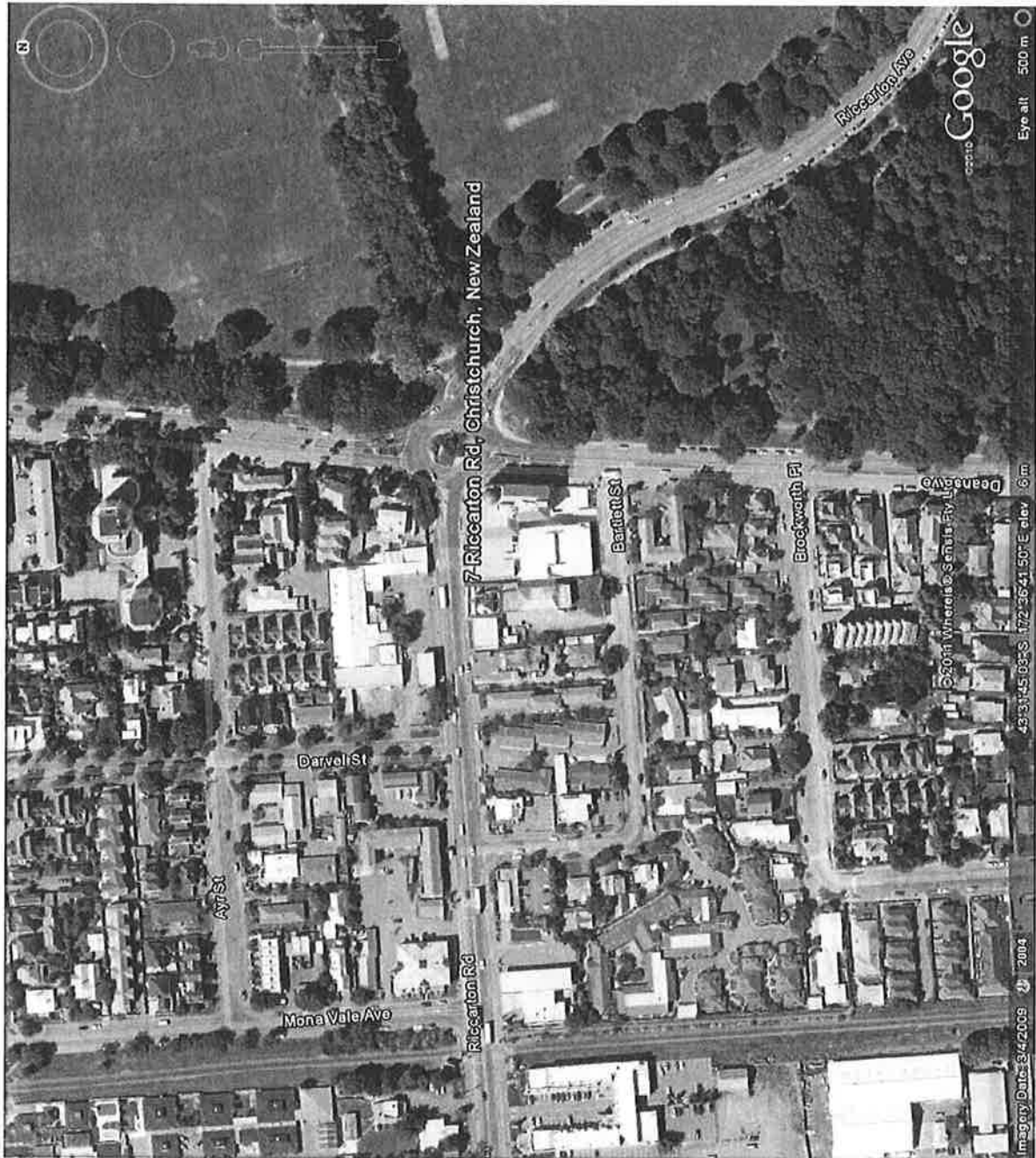
Report Reviewed By:

Jon Devine
BE(Hons) ME (Civil) CP Eng IntPE
Director

APPENDIX 1

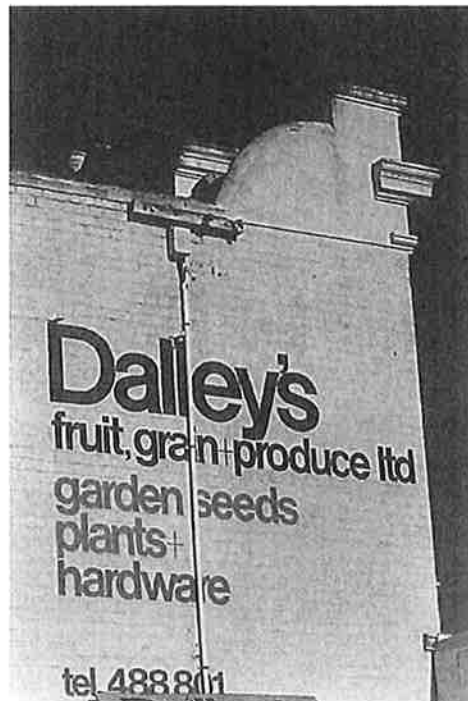
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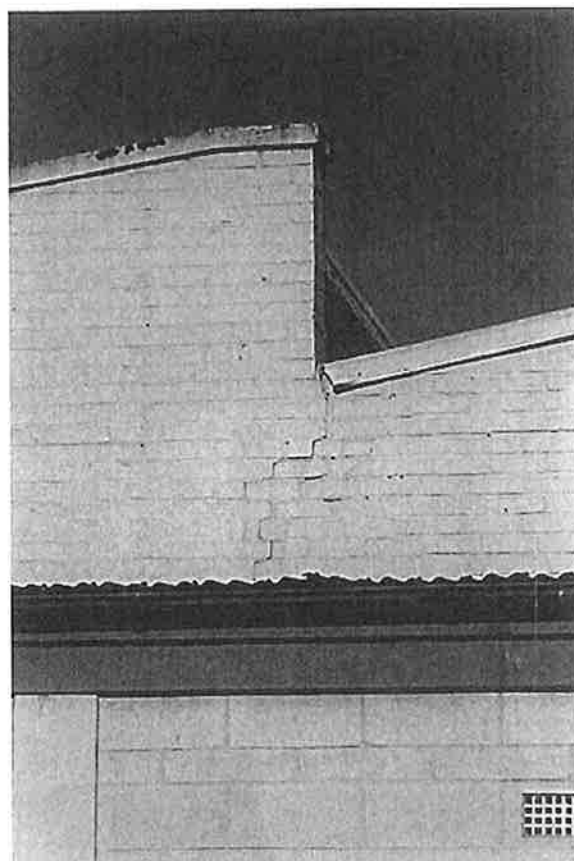


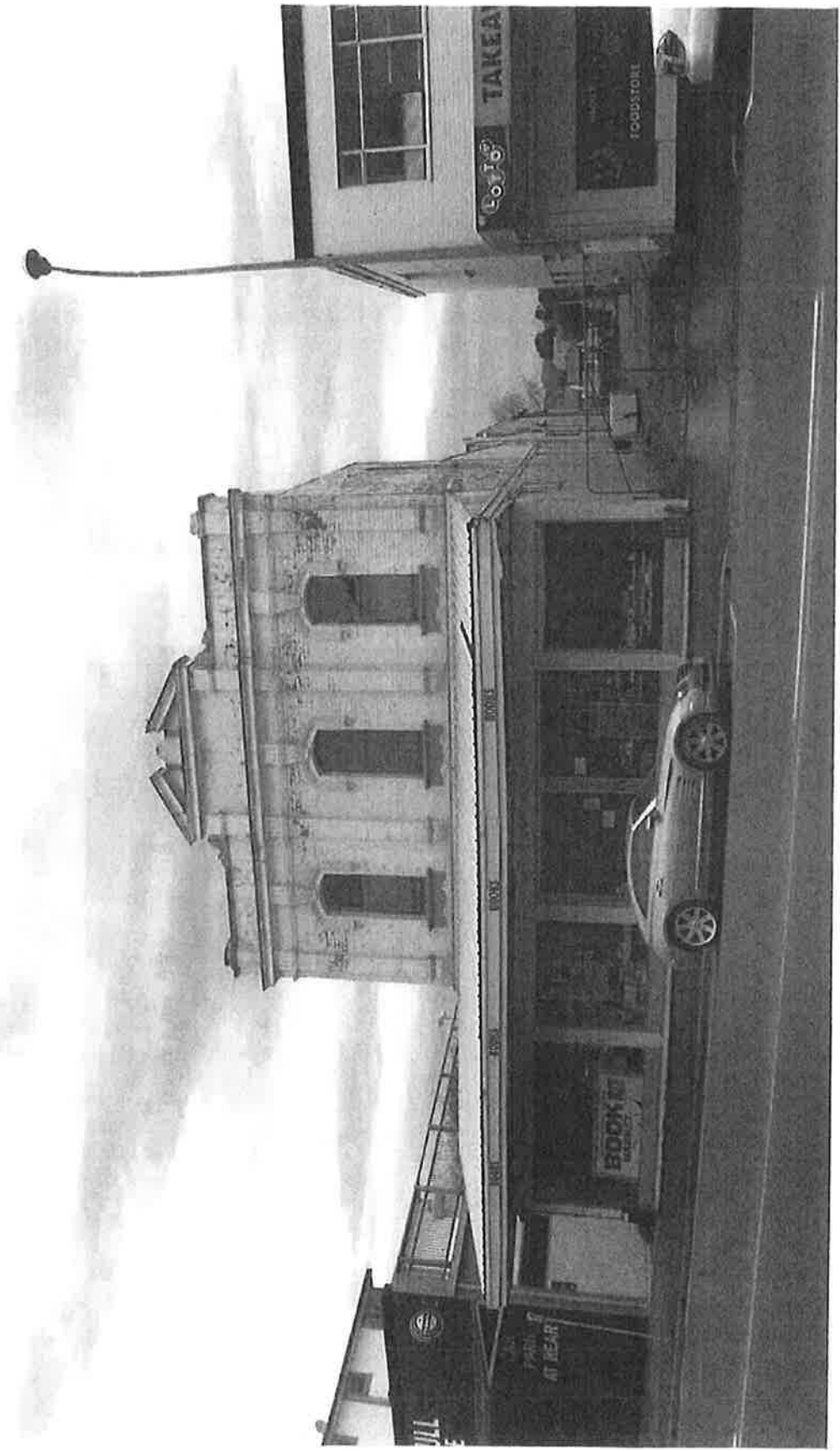


APPENDIX 2

Record of photos taken in 1993 by the Christchurch City Council during Seismic Risk Buildings Survey

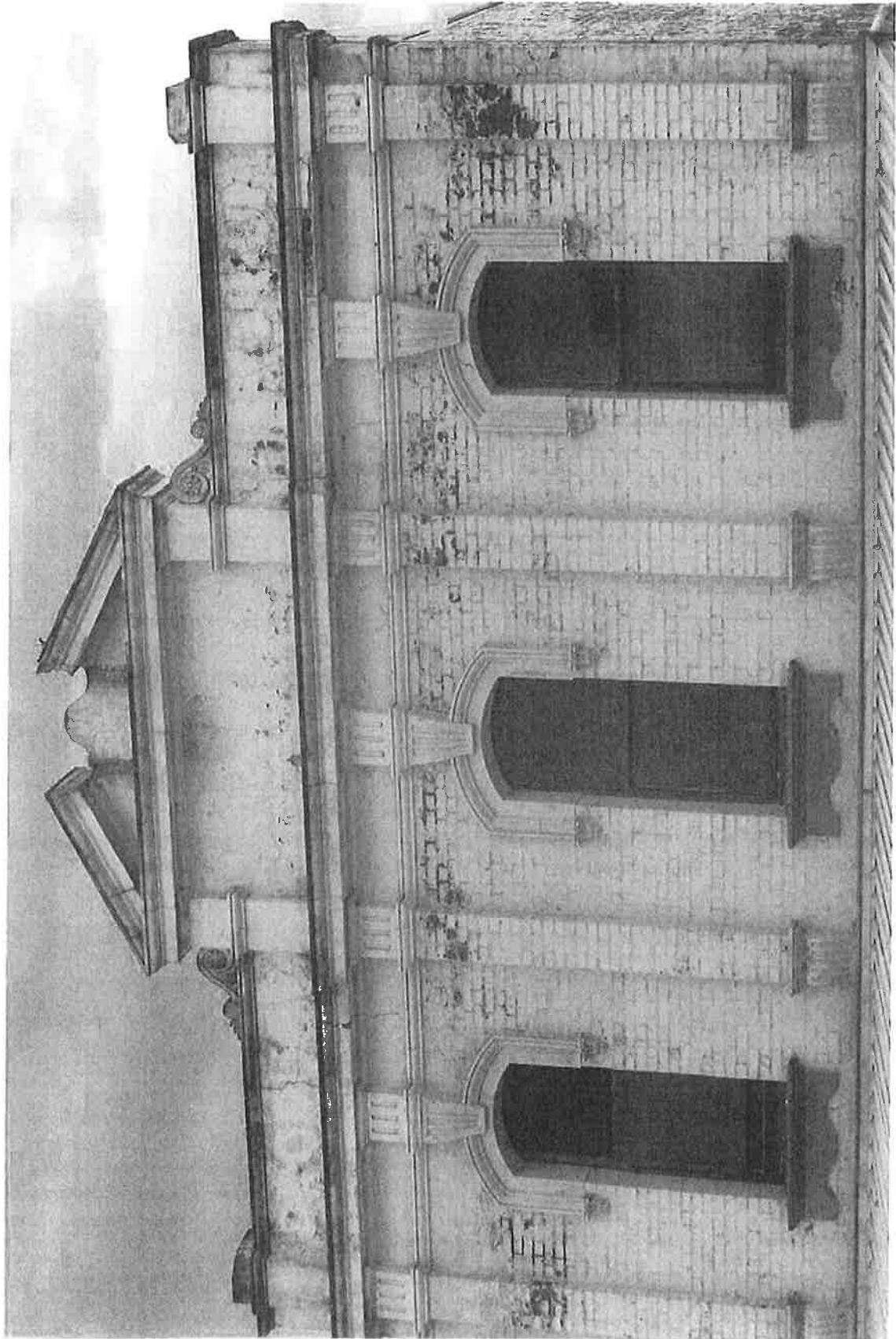




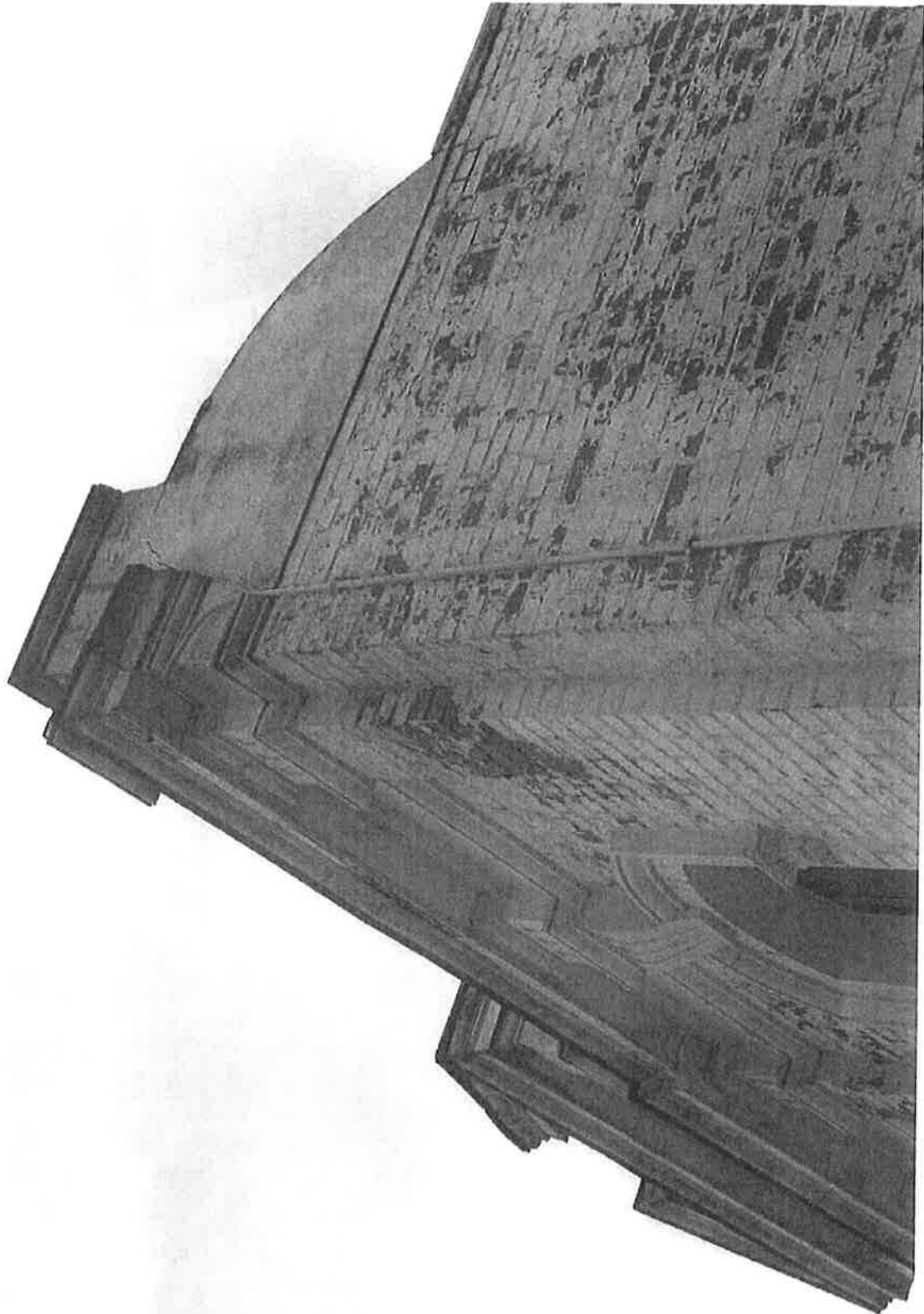


APPENDIX 3

Photographs taken after 4th September 2010 earthquake







APPENDIX 4

Photographs of damage following the 22nd February, 2011 earthquake



