INDEPENDENT ASSESSMENT ON EARTHQUAKE PERFORMANCE
OF
593 Colombo Street

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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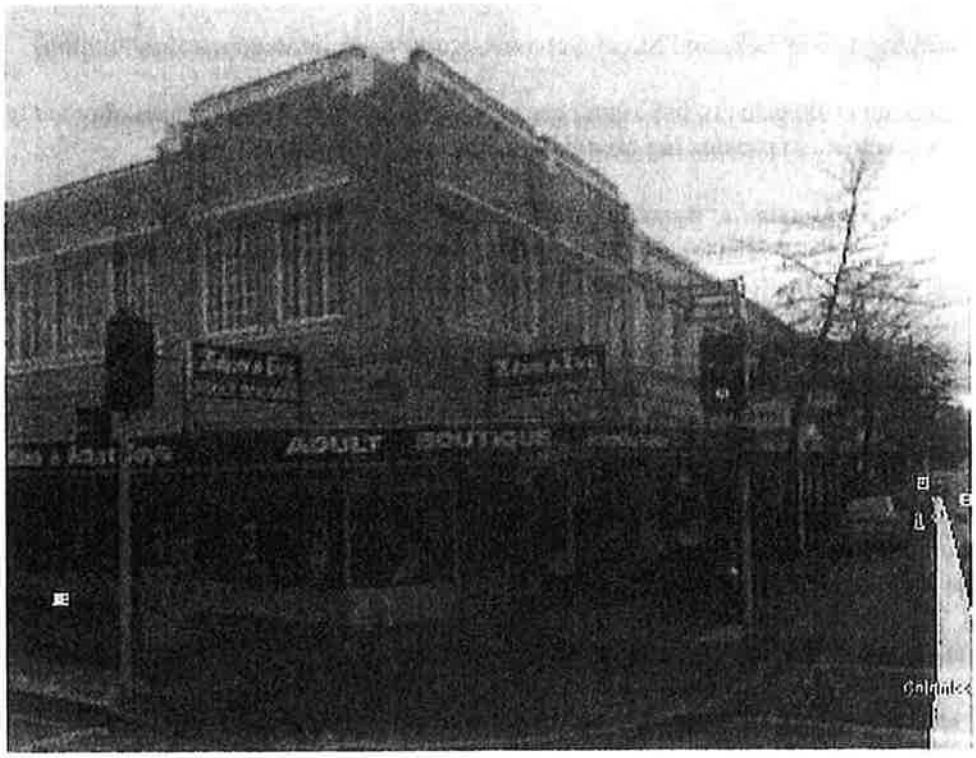

Introduction

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 593 Colombo Street, Christchurch, during the Canterbury earthquake sequence. Note that the property 593 Colombo Street incorporates the tenancies often referred to as 187 – 189 St Asaph Street.

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 before the building was demolished.

Location of Building

The building was located on the northwest corner of Colombo Street and St Asaph Street.

The location of the building in the Christchurch CBD is shown on the aerial photograph of Christchurch included in Appendix 1.

Description of Building

The building at 593 Colombo Street was a two storey un-reinforced masonry building.

The building is expected to have been constructed in the early 1900's. Christchurch City Council have been unable to provide the original drawings for the building.

The building had a timber framed roof and timber first floor with un-reinforced masonry exterior walls. Inter-tenancy walls on the ground floor were primarily un-reinforced masonry with some internal walls to the first floor of timber construction.

The walls to the Colombo Street and St Asaph Street frontage were penetrated by relatively significant openings at both ground and first floor level.

Compliance

It is assumed that the building complied with the requirements of the Building Act 1991 due to the building pre existing the Building Act and all alterations being undertaken to the satisfaction of the Christchurch City Council.

Christchurch City Council Policy on Earthquake Prone Buildings

We understand that following the introduction of provisions in the Municipal Corporation Act for territorial authorities to require building owners to strengthen or demolish un-reinforced masonry buildings in 1968, the Christchurch City Council applied for and was granted powers under Section 301A of the Municipal Corporations Act. The Christchurch City Council appears to have adopted a passive approach to the upgrading of earthquake risk/prone buildings.

Christchurch City Council records include a letter from the Christchurch City Council's Engineers Department to the owners of the building 593A Colombo Street in 1977, advising that

an inspection of the building in relation to the tenancy at 593A Colombo Street identified the following items which may need attention in the near future:

- The west gable parapet is leaning outwards
- The east frontage projections appear loose, and
- The first floor at the north east of the building appears to have subsided slightly,

among other maintenance works.

The letter referred to a previous letter of 25th October, 1977 that is not on file and the Christchurch City Council letter to the building owners commented that "As the building was erected prior to 1935, it may not comply with section 301A of the Municipal Corporations Act. An independent structural report should be obtained." There appears to be no further correspondence in respect of this matter.

The Christchurch City Council undertook a Seismic Risk Building-Survey of the building 593/593A Colombo Street in 1991 that assessed the building as a Classification B earthquake risk buildings with a score of 14. The assessment recommended remedial action within 2 years. The assessment identified "horizontal cracking on parapet". . The results of the Seismic Risk Building-Survey do not appear to have been communicated to the owner. A Hazardous Appendage-Survey identified an approx "1.8 m" high parapet "some cracking," a 200 cornice projection and recorded noticeable cracking to the building

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

This policy was reviewed in early 2010.

Events Subsequent to 4th September 2010 Earthquake

Following the 4th September, 2010 earthquake a Rapid Assessment-Level 1 of the tenancy at 187 St Asaph Street was undertaken on 5th September, 2010. The tenancy at 187 St Asaph Street integrally connected to the tenancy 593 Colombo Street. The inspection identified that "Parapet badly cracked. Risk of further collapse". That tenancy was given a yellow sticker.

A Rapid Assessment-Level 1 was also undertaken on the buildings at 593 to 599A Colombo Street on the 5th September, 2010. The Rapid Assessment-Level 1 recorded "Minor cracking of masonry. Smashed windows at 595 Colombo, soffit of verandah buckled. Minor interior cracking in one upstairs unit inspected". The building was given a green placard.

Holmes Consulting Group Ltd were engaged by the owners to inspect the building following the 4th September, 2010 earthquake. Alistair Boys of Holmes Consulting group undertook a Rapid Assessment-Level 2 of 593 Colombo Street on the 24th September, 2010. The assessment identified "damaged masonry at downpipe locations at top of west wall and apparent separation of L2 floor and URM walls (and internal partitions) possibly pre-existing, further assessment required". Supporting documents comment that the St Asaph Street façade may have moved out by 10mm but that there was some evidence that the movement may have been pre-existing as there was newspaper stuffed into cracks.

The Rapid Assessment-Level 2 assigned a yellow placard to the tenancy 593 Colombo Street. The Christchurch City Council do not appear to have a record of this Rapid Assessment.

Personnel from Holmes Consulting Group inspected the building again on the 4th October, 2010. A site report records that a 10mm to 20mm gap was identified on the east wall between the timber framed floor and the brick façade. The displacement was observable from the exterior. A 10mm to 20mm gap was observed between the timber framed floor and the brick façade to the south wall. The west wall above first floor ceiling level was identified to be leaning outward. No gaps were identified between the floor and brick walls on the north side. The engineers commented that the façade appeared to be in good condition. Holmes Consulting Group provided the building owners with suggested temporary strengthening work to the east, west and south wall with the site reports of the 4th October, 2010.

In an email to NAI Harcourts, the building owners agents, of the 6th October, 2010, Mr Seville recommended that an inspection of the roof be carried out urgently to check the stability of the exterior walls. In further evidence provided by DLA Phillips Fox, Mr Seville comments that he believes Holmes Consulting Group were requested to place the concept design works relating to the strengthening works on hold pending confirmation of funding.

On 13th October, 2010 the Christchurch City Council record in an Enforcement Team Notice Coversheet that the yellow placard status was still in force in respect of 187 St Asaph Street. The notice required a CPEng Engineer to provide a report on the safety of the building. The Enforcement Notice Coversheet was recorded as having been processed on 26th October, 2010. The danger was identified as "notice to fix for work relating to façade / parapet south west street façade." A Rapid Assessment-Level 2 dated of 13th October, 2010 assessed that the overall building damage at 11 to 30%. The Rapid Assessment noted "Front footpath fenced off. Access at side open. Detailed engineering evaluation recommended."

Holmes Consulting Group's engagement was extended by the building owners on 19 October, 2010 to undertake the design of temporary shoring works, liaise with the contractor carrying out the work and prepare a concept design for strengthening the building. Holmes Consulting Group prepared documentation showing the general concept for strengthening the building which included temporary shoring requirements. The documentation highlights in red work which Holmes Consulting Group assessed as being "required repairs prior to resumption of occupancy." Holmes Consulting group required the damaged structure to be restored to its original strength and damaged non-structural portion to be removed or replaced."

A brief synopsis of the position reached and the proposed plan for action was sent by email to NAI Harcourts on 24th November, 2010.

Arrangements were made for a scissor lift to be available and an inspection of the roof was made on 26th November, 2010. During the site inspection staff identified additional damage to the interior brick walls at ground floor level perpendicular to the south wall on St Asaph. Removal of plaster revealed lateral displacement between the brickwork. Photos of the damage were forwarded to NAI Harcourts on 29th November, 2010.

A further inspection took place with representatives of NAI Harcourt present on 29th November, 2010. At the meeting the client's agent requested Holmes Consulting Group to incorporate the recommended temporary securing works as part of the final strengthening works. The temporary securing works recommended by Holmes Consulting Group were:

- The removal of two internal brick walls and replacing with a new blockwork wall western end of the building
- Replacement of some internal steel posts with new steel posts at ground floor level on the Colombo Street façade
- Provision of new sections of ply ceiling diaphragm and ties into the external walls around three sides of the building – including Colombo Street and
- Localised repair of two damaged section of parapet on St Asaph Street and western elevation.

Richard Seville of Holmes Consulting Group forwarded Holmes Consulting Group's drawings 10538071 SK1 to SK4 to Chris Chapman on 11th February, 2011. We understand that none of the work included in Holmes Consulting Group's documentation was undertaken prior to the 22nd February, 2011 earthquake. Holmes Consulting Group advised they had no further involvement with the building after completion of the sketch plans.

The next inspection report is a Council Engineer's Re-inspection of Damaged Buildings report for the building 187 St Asaph (593 Colombo Street) dated 14th February, 2011. This inspection report identifies "Internal walls show large shear cracks between 187 / 189 (St Asaph Street) tenancy. Risk of damage from bricks and overflow onto neighbouring access way" and under general comments, "No work to secure overflows since 12th October – this is a safety risk to users of the accessway. Also the neighbouring building's wall has collapsed with the wall and roof left unsecured. This area needs to be fenced off. Building has been red stickered". Under protection measures it noted "Fencing required beneath overflow and to the driveway next to the building at 185 St Asaph Street where the wall has collapsed".

On 16th February, 2011 there is a record of a conversation between a Council employee and Chris Chapman, Property Manager .The conversation records that Mr Chapman informed the caller "the structural engineer has designed repair options and they have only just been submitted to a contractor for costing. He is working on a report that will discuss the work that is to be done to bring the building up to 67%. The majority of the building will remain un-tenanted for the long term. After the pricing has been done, it will be up to the owners (and insurers) whether they want to repair or demolish."

Documentation forwarded by Chris Chapman following the earthquake includes the comments "We are not aware of any structural strengthening having been undertaken to the building. The inspection undertaken after September 4 earthquake by the engineers provided confirmation that the building was earthquake prone and as such the owners were in communication with structural engineers on requirements to deal with that". Chris Chapman records that they were not aware of any further assessments after the 26th December earthquake.

It appears that the placarding of the buildings following the 4th September, 2010 earthquake was on the separate assessment of the tenancies 187 St Asaph Street and 593 to 599A Colombo Street.

The building suffered significant damage in the 22nd February, 2011 earthquake with the upper floor facades to both St Asaph Street and to Colombo Street falling outwards. The building was inspected on 19th March, 2011 and assigned a red placard. A recommendation was made to "Demolish Entire Block".

Information forwarded by Chris Chapman includes a site inspection report by Sinclair Knight Merz. This report was compiled at the request of NAI Harcourt Industries. The site inspection report assesses the property at 593 Colombo Street. The building is recorded as having a red placard and that a Level 1 assessment was undertaken with the comments "no placard displayed because building is to dangerous to approach for placement. Clearly unsafe. Walls on street frontage collapsed. Roof, floors and internal walls partially collapsed, refer to photos. Appears unsalvageable and likely to be demolished subject to CCC approvals etc."

Structural Failure

The first floor façades of the building failed by an outward rotation of the façades above the first floor support in the severe shaking during the 22nd February, 2011 earthquake. These walls separated from the internal walls, party walls and adjoining façade with near vertical cracking near the junction between the walls.

The code lateral load coefficient for a façade to an elastic responding structure in Christchurch at the time of the earthquake sequence was 0.86g. 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 indicated 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 acceleration 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 facades have significant penetrations that affect both the weight and strength of the façade. The above figures demonstrate that the facades may not have survived the Canterbury earthquake sequence had the facades been adequately secured at roof level.

In the unsecured condition, failure of the external facades was almost inevitable in the severity of shaking that occurred during the 22nd February, 2011 earthquake.

Issues Arising from Review

Upgrading of un-reinforced masonry buildings
The building at 593 Colombo Street had remained in a relatively original condition up until the recent earthquakes.

The Christchurch City Council's, Engineers Department identified potential structural issues with the west gable parapet (above the lane on the west side of the building) and that the east frontage projections that appeared loose (Colombo Street frontage) in 1977. The Christchurch City Council advised the owners that an independent structural report should be obtained in respect of these issues. The Christchurch City Council appear not to have followed up on this request and the owners took no action.

The damage that occurred to the building in the 22nd February, 2011 earthquake demonstrates the risk that un-reinforced masonry buildings pose to the occupiers of the building and people in the

vicinity of the building at the time of such an event. As the end building of a series of interconnected un-reinforced masonry buildings, the building at 593 Colombo Street suffered more significant damage than the adjoining buildings.

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. 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 experienced during the 22nd February, 2011 earthquake. It is unfortunate that the Christchurch City Council did not require building owners to remove or secure the parapets to buildings along the street frontages.

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

Rapid Assessments

Our understanding of the rapid assessment process is that a building, and not individual tenancies, was to be assessed and that once the building had been assessed, the entry to each tenancy on the ground floor and the entry to all upper level floor tenancies would be assigned a placard. The assignment of a yellow sticker to the tenancy 187 St Asaph Street should have resulted in a yellow placard to all tenancies in the building 593 Colombo Street that should have resulted in the entire building 593 Colombo Street being un-occupied. It appears that the assessor was predominantly concerned over damage at the south west corner of the tenancy 187 St Asaph Street and Christchurch City Councils attention appears to have remained focussed on the damage to the south-west corner of the tenancy 187 St Asaph street.

Following the 4th September, 2010 earthquake the building 593 Colombo Street was recorded as being green stickered, essentially closing out the post earthquake assessment process that was undertaken using largely voluntary industry personnel for the building. Presumably as a result of the yellow sticker on the tenancy 187 St Asaph Street, the building owner/insurers engaged Holmes Consulting Group to inspect the building.

Holmes Consulting Group identified that the building had suffered some damage that Holmes Consulting Group assessed as sufficiently significant that some remedial work should be undertaken prior to occupancy of the building. Holmes Consulting Group assigned a yellow placard to the building.

The Christchurch City Council appear to have no record of the Rapid Assessment-Level 2.

A significant feature of the collapse of most un-reinforced masonry buildings was the outward collapse of the exterior façade of the upper floor rotating about the supporting structure at the upper floor. The failure involves a separation from the roof structure and a tension tear of any

return or party wall. Should the connection between the façade and the return walls/party walls be damaged in an earthquake, the damage cannot be inspected from the exterior of the building.

The concealment of the damage on the interior of the building suggests that the Rapid Assessment-Level 1 does not provide a sufficiently robust process for protecting the public from a failure of the façade of an un-reinforced masonry building in a subsequent aftershock. There are limitations in the Rapid Assessment-Level 1 inspection, undertaken solely on the exterior of the building, as a means of assessing damage to an un-reinforced masonry building in a significant earthquake. The risk of collapse of un-reinforced masonry buildings, in whole or in part, from a significant aftershock, justifies a greater level of inspection and assessment prior to re-occupancy or public access near un-reinforced masonry buildings following a significant earthquake.

It is suggested that the minimum level of assessment of un-reinforced masonry buildings after a significant earthquake is a Rapid Assessment-Level 2.

Basis of Rapid assessments

The Rapid Assessment process focuses on damage caused to the building by the recent earthquake. The process assumes that the risk that existed before the earthquake is acceptable in the period following the earthquake, subject to only limited damage having occurred to the building. Historically aftershocks have caused lesser levels of shaking than the initial earthquake.

The earthquake of 22nd February, 2011 has demonstrated that the occupancy and public access in the vicinity of un-strengthened un-reinforced masonry buildings below a minimum strength level may involve an unacceptable risk to the public and occupants of these buildings. It is recommended that the basis of the rapid assessment process be reviewed.

Owners Responsibility for Public Safety

Holmes Consulting Group were engaged by the owner to design temporary shoring work and prepare a concept design for strengthening work. Initial suggestions for remedial work were forwarded to the owners agents on 6th October, 2010. At the owners agents request, the final documentation of the remedial works was incorporated in the conceptual strengthening work forwarded to the building owners agents on 11th February, 2011. Holmes Consulting Group's plans 105380.71 SK1 to SK2 include work to the Colombo Street façade that they recommended should be undertaken prior to occupancy. It is understood that the work had not been commenced by 22nd February, 2011.

It is suggested that in the interests of public safety, the role and responsibility of the owner be clarified in the event of a building being damaged in a significant earthquake.

In the interests of public safety, it is important that the owners and owners agents notify the controlling authority if the condition of the building differs from the placard assigned to the building.

Territorial Authority response to yellow notice

The Christchurch City Council appear to have issued a Building Act Notice following the assignment of a yellow placard to 187 St Asaph Street. As the Christchurch City Council appear not to have received the Rapid Assessment-Level 2 on 593 Colombo Street, the Christchurch City Council took no action in respect of Holmes concerns over the stability of the Colombo Street façade.

Barriers

The tenancy 187 St Asaph Street was damaged in the 4th September, 2010 earthquake and assigned a yellow placard. Photographs of the building following the 4th September, 2010 earthquake and prior to the 22nd February, 2011 earthquake show that the St Asaph Street frontage had been barriered to the second white line from the street gutter with a container being placed along a part of the street frontage. The building at 593 Colombo Street was yellow stickered following Holmes Consulting Groups Rapid Assessment-Level 2 undertaken on the 24th September, 2010.

While the Christchurch City Council provided barriers to protect the public from a failure of the damaged St Asaph Street façade, the barriers did not extend sufficiently out into Colombo Street to protect the public in Colombo Street from a failure of the Colombo Street façade.

Clearly the focus of the barrier placement was on protection of the public from a failure of the identified damaged at the south west corner of the St Asaph Street façade.

The Canterbury earthquake series has demonstrated that after a significant earthquake, the risk of a significant after shock is high and controlling authorities need to recognise the risk of failure of building facades to un-strengthened un-reinforced masonry buildings if a repeat of the tragic loss of life that occurred on the 22nd February, 2011 is to be prevented. This would require barriers to be erected to isolate public access to the full extent of the fall zone of un-strengthened un-reinforced masonry buildings.

It is recommended that the territorial authority should maintain the barriers to the full extent of the fall distance of un-reinforced facades of un-strengthened un-reinforced masonry buildings and restrict access to those buildings until a strength assessment to an acceptable minimum strength requirement is provided by a CPEng engineer engaged by the building owner.

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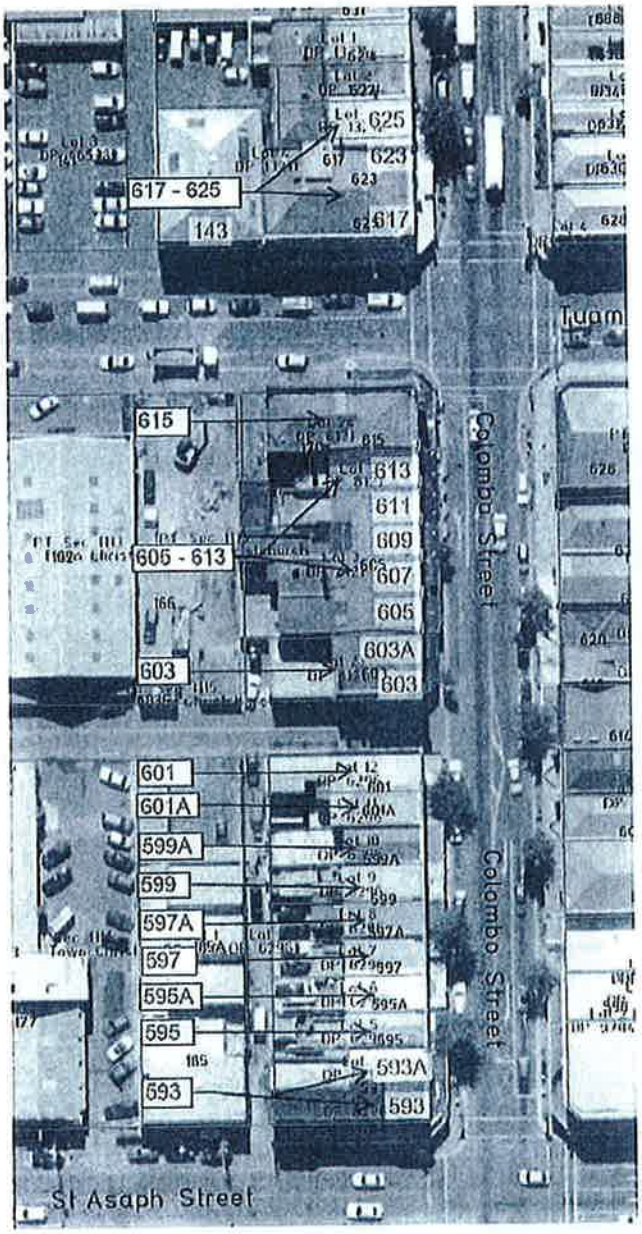
APPENDIX 1

Site Plans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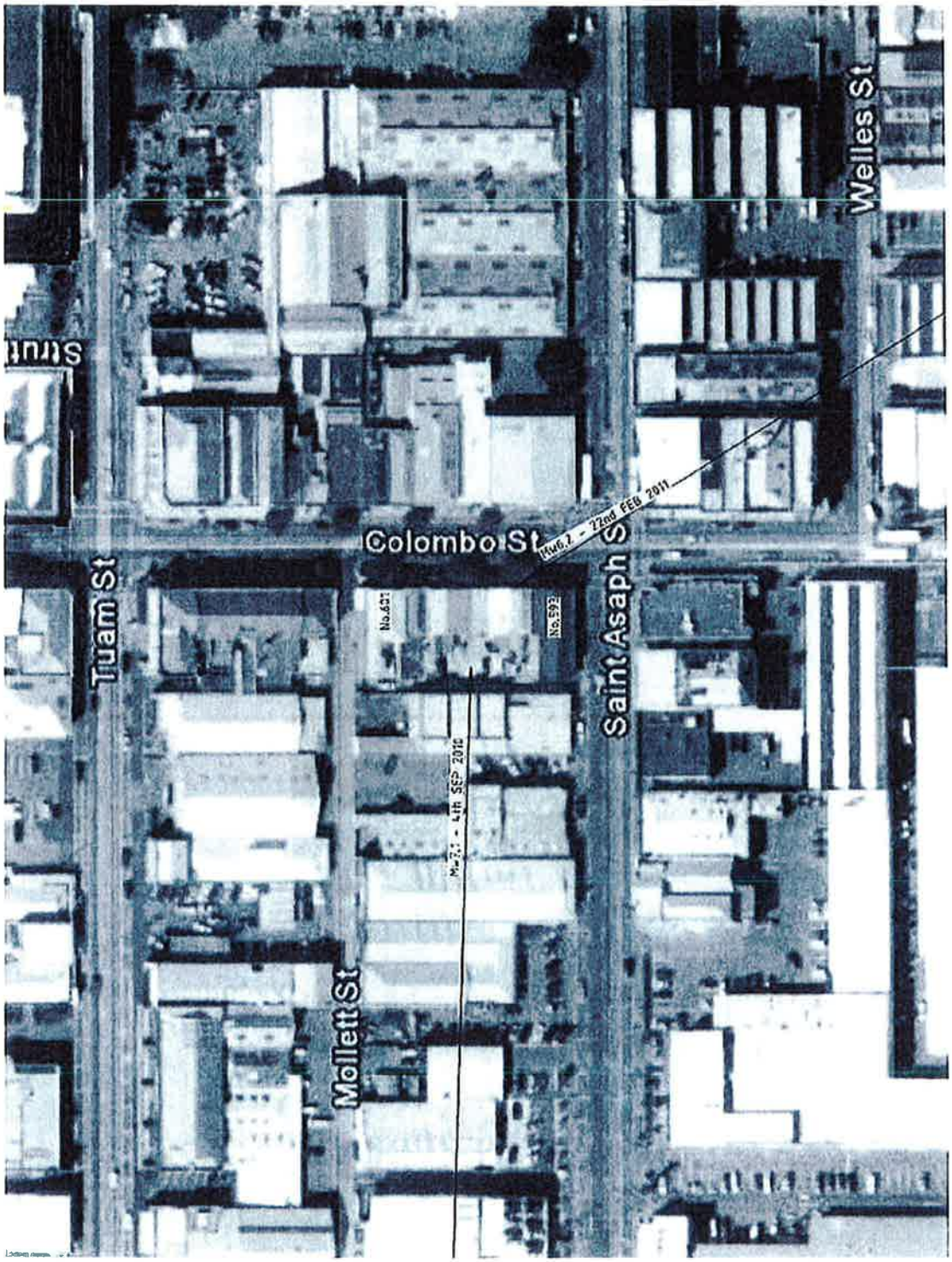
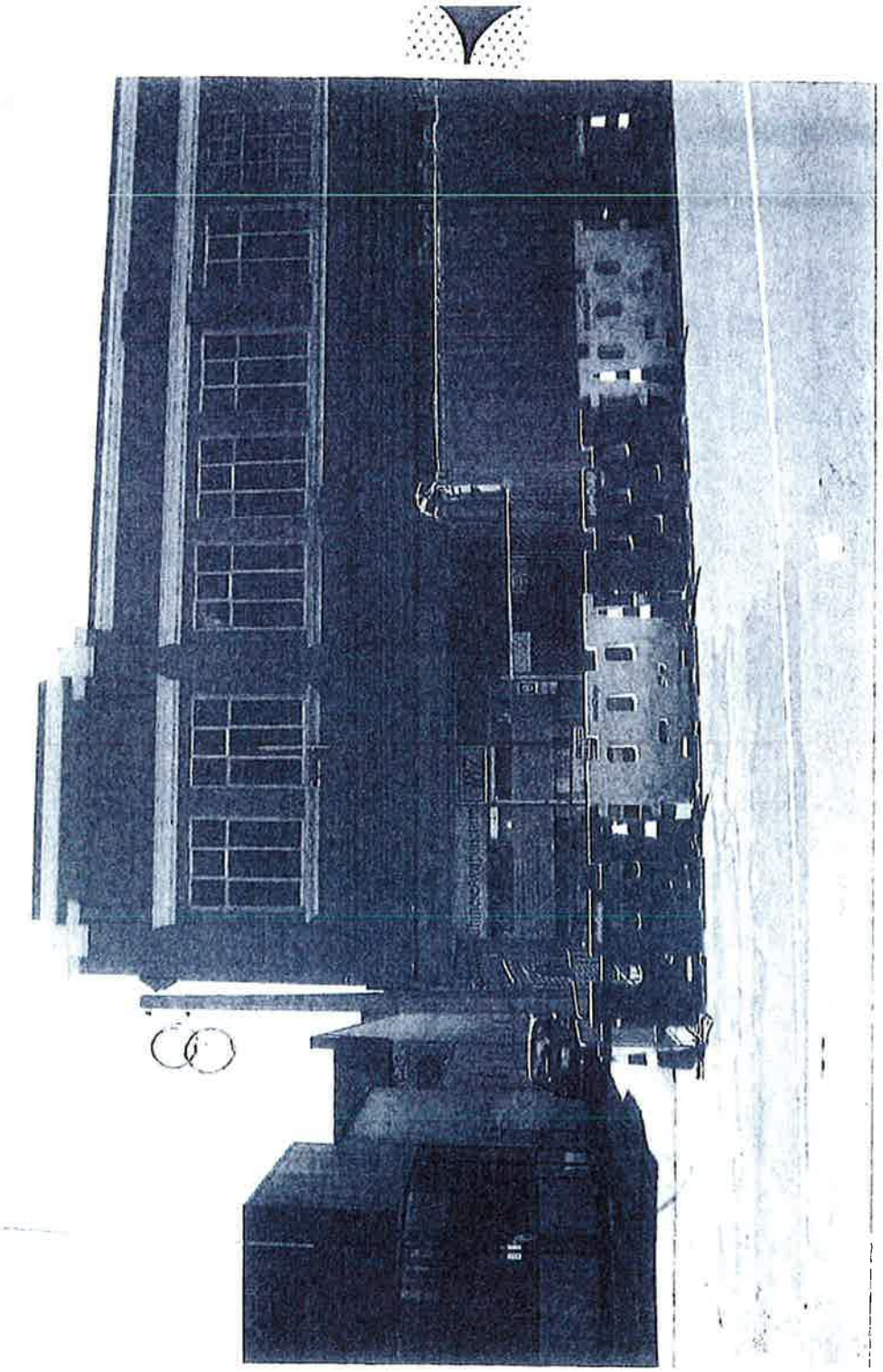


APPENDIX 2

Condition of Building following 4th September 2010 earthquake



APPENDIX 3

Building damage following 22nd February 2011 earthquake

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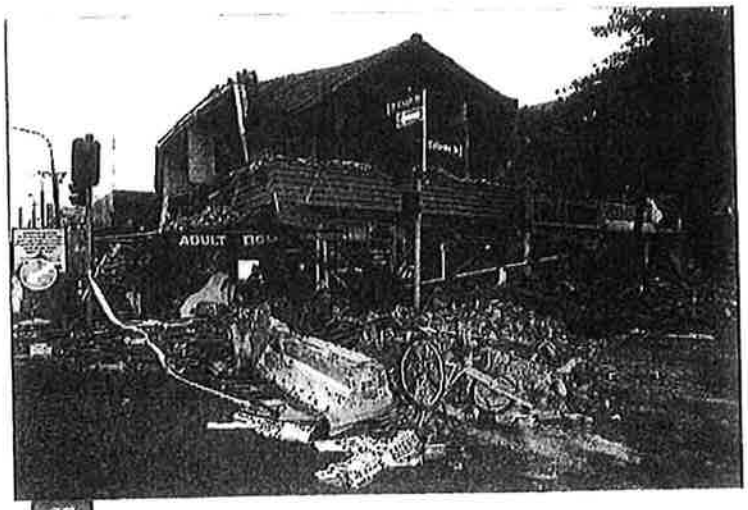

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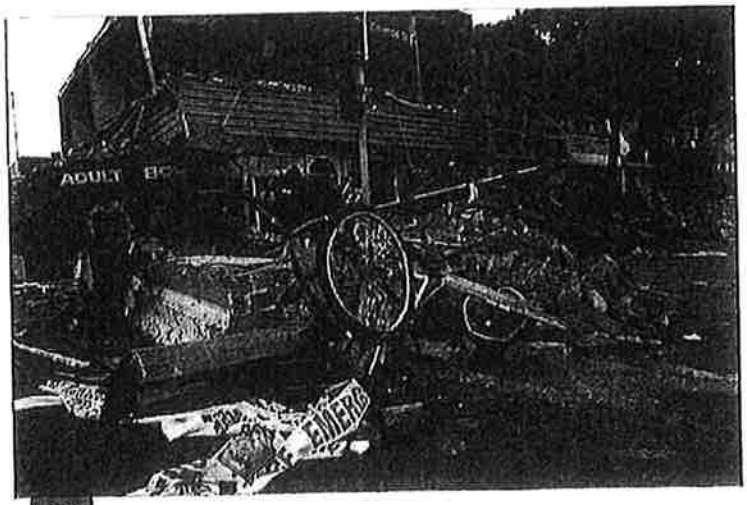

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