

**INDEPENDENT ASSESSMENT ON EARTHQUAKE PERFORMANCE  
OF  
601 – 601A 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 601-601A Colombo Street, Christchurch, 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 601-601A Colombo Street was located on the corner of Colombo Street and Mollett 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 601-601A Colombo Street had a narrow street frontage to Colombo Street and a longer street frontage to Mollett Street. The building was constructed with a common party wall between tenancies and the building had a common party wall with the adjoining building to the south.

The building at 601-601A had a reasonably open facade to Colombo Street. The façade of the building was less heavily penetrated on the Mollett Street frontage. The buildings had high parapets to the Colombo Street façade, with the parapet reducing in height along the Mollett Street frontage.

The buildings were of un-reinforced masonry construction. The roof framing and the first floor construction were of timber.

## Compliance

A review of the Christchurch City Council records indicates that the building complied with the requirements of the Building Act 1991 due to the building pre existing the Building Act and no alterations or change of use occurring since the introduction of the Building Act 1991.

## Christchurch City Council policy on Earthquake Prone Buildings

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

While we are aware that the Christchurch City Council undertook a Seismic Risk Building-Survey and Hazard Appendage-Survey of many buildings, we have not sighted such an assessments in respect of these buildings.

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

This policy was reviewed in early 2010.

## Events Subsequent to 4<sup>th</sup> September 2010 Earthquake

The building was damaged in the 4<sup>th</sup> September, 2010 earthquake. The Rapid Assessment -Level 2 identified that a portion of the Mollett Street façade collapsed. Photos show the extent of the collapse and severe cracking of the north (Mollett Street) wall. (Refer Appendix 2.) The building was assigned a red placard. The Rapid Assessment-Level 2 identified further unsafe hazards from falling and required barricades along the Mollett Street frontage.

Marton Sinclair of Eliot Sinclair inspected the buildings on 6<sup>th</sup> September, 2010. Marton Sinclair noted “A double brick wall on the north side of the building had collapsed onto Mollett Street during the 4<sup>th</sup> September, 2010 earthquake leaving the roof partially supported.”

“The interior of the southern building at 601 Colombo Street was not inspected but is likely to have been of similar construction”. “Our photographs, taken on 15<sup>th</sup> September, 2010 record that there was a stepped vertical crack in the transverse dividing wall at the south east corner of Unit 601A. This crack was related to the predominantly north south shaking of the September earthquake which had affected the north and south walls rather than the eastern façade fronting onto Colombo Street”

“There was also a small crack in the east façade at the north east corner of the building. The façade onto Colombo Street appeared largely undamaged apart from the cracking at this corner. However we consider the building still needed to be cordoned off. The crack of the eastern façade and in the transverse dividing wall did not indicate any outward movement of the façade.”

Eliot Sinclair reported on the building on the 15<sup>th</sup> September, 2010. The report concluded “That the building was unsafe to occupy as a part of the upper level of the north wall had collapsed onto Mollett Street. The west wall was also severely cracked towards the rear of the building.”

“As noted in the report it was apparent from our inspection that the building needed to be demolished however this was not seen as urgent as Civil Defence had erected barriers along Colombo Street frontage of 601 and 601A and in Mollett Street and the building was cordoned off.”

A further Rapid Assessment-Level 2 was undertaken on the 15<sup>th</sup> October, 2010 following which the Christchurch City Council wrote to the building owners requesting the owners to provide Council with a report by a Chartered Professional Engineer on the structural condition of the building and certification that “the building is not a risk to adjacent buildings or areas such as roads, footpaths and other areas that the public generally has access to”. Documentation records that the building at 601A Colombo Street was assigned a red placard on 15<sup>th</sup> October, 2010. The Notice Cover sheet notes “area fenced off safe”

A Rapid Assessment-Level 1 was undertaken on the building on 27<sup>th</sup> December, 2010, following the Boxing Day earthquake. A Rapid Assessment-Level 2 was recommended. The Rapid Assessment-Level-1 notes “significant damage to structural walls, party walls, fire walls and all structural framing”. Significant damage was noted to the roof structure, loose and insecure debris, bricks and glass. The building was recorded as having previously been assigned a red placard and that the placard had been removed and a new red placard posted. On 28<sup>th</sup> December, 2010 the Christchurch City Council wrote to the owners of the building at 601 – 601A Colombo Street advising that the Council considered the building to be a dangerous building as defined under the Building Act. The Council issued a Section 124 (1) (b) Building Act notice. Council required the owners to reduce and/or remedy the damage to their building.

A record plan dated 7<sup>th</sup> January, 2011 identifies an area in Mollett Street extending into Colombo Street requiring a full cordon to be imposed on an aerial photo of the site. The area extends along a portion of the east wall of the property. The cordon was to be labelled ‘Extreme Hazard Do Not Enter’.

There was an engineers re-inspection on 31 January, 2011 which reiterated that an engineers report was required.

The building was re-inspected again on the 14<sup>th</sup> February, 2011 and the assessment noted that the building was badly damaged and an urgent CPEng certification form was required. The Building owner never provided a CPEng certification form.

In the 22<sup>nd</sup> February, 2011 earthquake the upper level of the Colombo Street façade of the buildings 601-601A Colombo Street fell into Colombo Street, the Mollett Street façade of the building fell into Mollett Street and the party wall was severely damaged.

## Structural Failure

The failure of the Mollett Street façade in the 4<sup>th</sup> September, 2010 earthquake was an out of plane failure of the first floor wall rotating at or near the first floor support due to inadequate support at roof level. Sufficient restraint was provided at each end of the wall to prevent failure of a section at each end of the wall.

The failure of the Colombo Street façade and the remainder of the Mollett Street façade in the 22<sup>nd</sup> February, 2011 earthquake is assessed as an outward rotation of the façade about the first floor support.

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 Unreinforced Masonry Buildings for Earthquake Resistance’ 2011. Calculations using these documents indicate that a 225mm thick un-reinforced masonry wall spanning 3m from first floor level to roof level and restrained at the roof would meet code requirements. Based on GNS Science records of measurements of accelerations in the Christchurch CBD during the 22<sup>nd</sup> 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 a 1.25g acceleration at first floor level. The analysis assumes no vertical acceleration occurs when the wall is subjected to the horizontal acceleration. The front wall to 601 – 601A Colombo Street has significant penetrations which

affect both the weight and strength of the façade. The above figures indicate that the façade 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 inevitable

## Issues Arising from Review

### Upgrading of un-reinforced masonry buildings

The building at 601-601A Colombo Street had remained in a relatively original condition up until the recent earthquakes. The damage that occurred to the building in the 22<sup>nd</sup> 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 601A Colombo Street suffered more significant damage than 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 relies on territorial authorities adopting and implementing a meaningful programme for strengthening and upgrading of un-reinforced masonry buildings and enforcing 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 22<sup>nd</sup> February, 2011 earthquake. It is unfortunate that the Christchurch City Council did not at least 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.

### Protection of public spaces

Tragically the earthquake sequence has highlighted the danger to the public of inadequately restrained street facades to many un-reinforced masonry buildings. The 22<sup>nd</sup> February, 2011 earthquake demonstrated the need for greater caution in the occupancy and access in the vicinity of un-reinforced masonry buildings following a significant earthquake.

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 22<sup>nd</sup> February, 2011.

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 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.

### **Owners Responsibility**

The delay in the building owners responding to the Christchurch City Council requirement for an engineers report on the building is of concern.

### **Barriers**

The building was damaged in the 4th September, 2010 earthquake and assigned a red placard. Photographs of the building following the 4<sup>th</sup> September, 2010 earthquake and prior to the 22<sup>nd</sup> February, 2011 earthquake established damage to the Mollett Street wall. and barriers were noted as required along the Mollett Street frontage. (Refer photos in Appendix 2) The barrier requirements were extended on the 12<sup>th</sup> October, 2010.

While the Christchurch City Council provided barriers to protect the public from a failure of the damaged Mollett 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 damaged Mollett Street façade. After a significant earthquake the risk of an 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 22<sup>nd</sup> February, 2011 is to be prevented. This may, depending on the risk of a significant aftershock, require barriers to be erected to isolate beyond the full extent of the fall zone of un-strengthened un-reinforced masonry buildings following a significant earthquake.

### **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**

### **Site Plans**







## **APPENDIX 2**

### **Record of damage following 4th September 2010 earthquake**



## **APPENDIX 3**

### **Record of damage following 22 February 2011 earthquake**



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