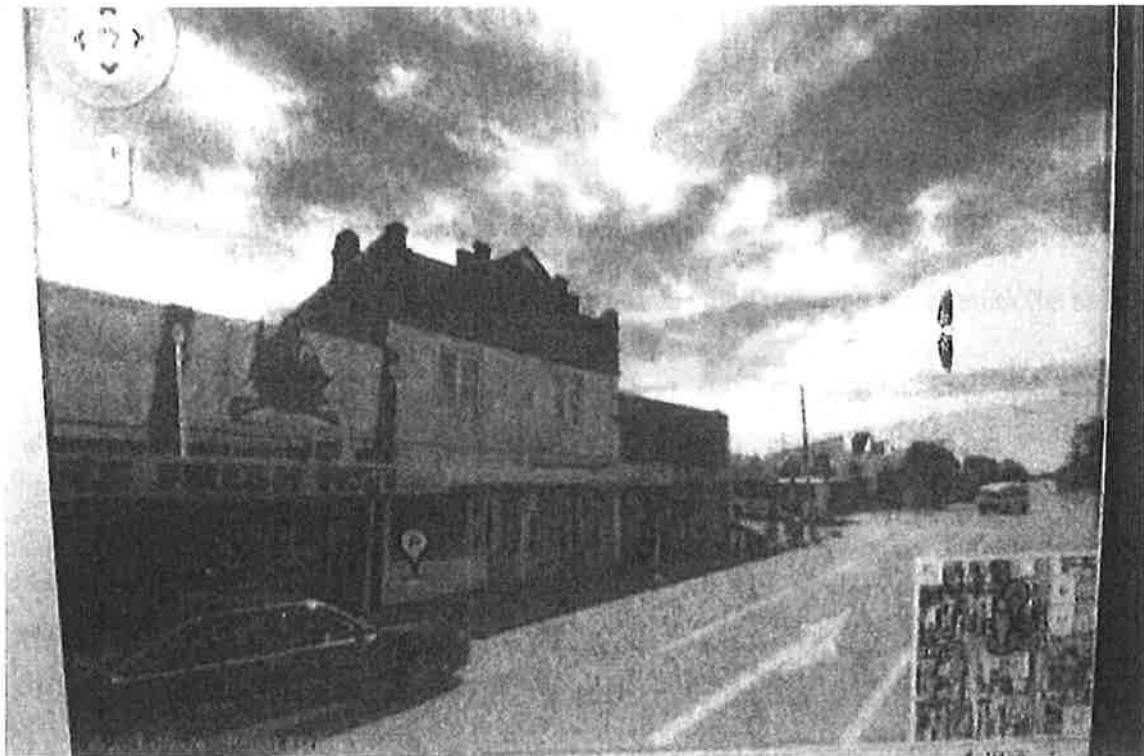


**INDEPENDENT ASSESSMENT ON EARTHQUAKE PERFORMANCE
OF
391-391A Worcester Street**

**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**

November 2011



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 391-391A Worcester 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 was located on the north side of Worcester Street between Fitzgerald Avenue and Stanmore Road. The location of the building, which is located outside the Christchurch CBD, is identified in the site plan in Appendix 1.

Description of Building

The building at 391 to 391A Worcester Street was a two storey un-reinforced masonry building constructed with timber roof framing and a timber first floor.

The building had an open façade to Worcester Street, particularly on the ground floor. There were significant window openings to the first floor façade. The building had a very high and ornate façade to the Worcester Street frontage.

A parapet of reduced height returned along the east and west walls of the building.

The adjoining buildings were both single storey buildings.

Compliance

We have not sighted any Christchurch City Council records in respect of the building prior to the Canterbury earthquake series.

In the absence of any review of the Christchurch City Council records, it is assumed that the building complied with the Building Act 1991 due to the building pre-existing the Building Act and no alteration or change of use occurring since the introduction of the Building Act.

Christchurch City Council Policy on Earthquake Prone Buildings

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

We note that despite many other buildings having been assessed, no Seismic Risk Building-Survey or Hazard Appendage-Survey, which we would expect to have identified the tall parapet to the Worcester Street frontage, appears to have been undertaken on the property.

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 4th September 2010 Earthquake

The building at 391-391A Worcester Street suffered damage during the 4th September, 2010 earthquake. As the building was outside the Christchurch CBD, we understand that no Rapid Assessment-Level 1 was undertaken of the building. The owner, Mr Loke records that after the 4th September, 2010 earthquake, the failure of the front parapet to the building caused roof damage but there was no placarding of the building by the Christchurch City Council. Mr Loke has indicated that he made several enquiries at the Christchurch City Council and he was advised that they were unable to assess it.

Photographic evidence following the 4th September, 2010 earthquake establishes that the upper portion of the parapet to Worcester Street fell back onto the roof of the building

Mr Loke hired the services of Contract Holdings Ltd to undertake temporary repairs following the 4th September, 2010 earthquake. This work involved removal of the top of the damaged chimney along the west wall, removal of east wall parapet and over-flashing, removal of debris from failure of front parapet, repair and propping of roof framing and provision of tarpaulins for temporary waterproofing of the building.

Mr Loke advises that the insurers appointed TM Consultants, as structural engineers to inspect and report on the building. TM Consultants report of the 11 October, 2010 records that at the time of inspection, the roof and upper west side walls were covered in tarpaulins and that the upper portion of the front brick façade had fallen onto the roof of the building, badly damaging the roofing and framing. The parapet to the eastern wall had been removed to just above roof level. The report records that the eastern brick wall near the front façade had several cracks, some old and some new, and that a portion of the east wall parapet had fallen on the adjoining building. The mortar in the brick joints was reported to be very soft and crumbly in this area. The west brick wall above the adjacent lower roof was recorded as being plastered and the wall reported to be in good condition. (Refer photos in Appendix 2).

The T.M Consultants noted that they could not inspect the brick walls at ground floor level as the walls were all lined. There was no sign of excessive movement which would indicate structural distress in these walls. The report identified that the roof needed to be reinstated, the front façade to be connected to the roof framing members and the eastern wall near the front façade needed to be re-built. There was a comment that the parapet to the east wall may need to be reinstated for fire rating purposes. The upper portion of the front façade that collapsed was not to be reinstated.

We are uncertain as to the extent of damage, if any, that occurred in the 26th December, 2010 earthquake although in a letter of 22nd July, 2011, Pak Loke, the building owner, commented that there was no additional damage after the Boxing Day earthquake.

The property was also inspected and assessed by EQC assessors on the 1st February, 2011. The Earthquake Commission Damage Assessment comments:

“External walls - South – front of street. Worcester Street. Upstairs and downstairs façade has multiple cracks. Timber bracing supported from front verandah is evident. Tarp over roof to make roof waterproof is attached to timber bracing. All is unstable.

External walls – East and West. 9 metre double brick walls with parapet – east parapet has collapsed and wall has emergency timber bracing on roof on adjoining property. Both brick walls have multiple cracks and are unstable.”

Under Chimneys, the assessor commented :

“Two chimneys damaged. Single chimney collapsed onto adjoining commercial business (Butchers shop). Must be completely demolished. Double chimney has cracked and twisted and was demolished to roofline and corrugated iron placed to cover opening in roof-not secure. Chimneys should be taken down. Debris to be removed from site.”

A report by Lewis and Burrow Ltd on the adjoining property 389A Worcester Street dated 2nd February, 2011 prepared for McLarens Young Christchurch Ltd, recorded that the 4th September, 2010 earthquake caused the parapet and wall of the neighbouring building to the east (391 – 391A) to fall onto the roof of the property 389A Worcester Street. The report noted that the bricks damaged the roofing which had already been repaired by the owner employing roofers. Subsequent aftershocks did not bring to light any further damage until the aftershocks of 26th December, 2010 caused damage to the building at 389 Worcester Street. Photos taken of the building at 391-391A Worcester Street on 27th January, 2011 indicate tarpaulins placed along the west wall of the building 391-391A Worcester Street at that time. (Refer Appendix 2). Other photos taken after the 4th September, 2010 earthquake indicate that the bricks that fell on the roof of the property 389A Worcester Street came from damage to the chimney along the west wall of the property 391-391 Worcester Street. (Refer photos Appendix 2).

The building suffered significant damage in the 22nd February, 2011 earthquake. A Rapid Assessment-Level 1 was undertaken on the building 391 – 391A Worcester Street on 2nd March, 2011. The Rapid Assessment-Level 1 identified severe damage and assigned a red unsafe placard and recommended demolition. Approval for demolition of the building 391 – 391A Worcester Street was granted on 27th March, 2011.

A review of photographic records established that a further portion of the front façade fell into Colombo Street and portions of the east and west walls fell onto adjoining buildings as a result of the 22nd February, 2011 earthquake. In particular a portion of the west wall tragically fell on and through the roof of the building 389A Worcester Street. Photos record that the south end of the west wall was intact after the earthquake and it is uncertain the actual extent of the west wall that failed.

Structural Failure

The top of the chimney along the west wall failed in the 4th September, 2010 earthquake as well as the parapet to the east wall. The upper portion of the parapet to the Worcester Street frontage rotated at roof level and collapsed onto the roof of the building, damaging the roof and roof framing.

The parapet and portions of the west wall collapsed onto the roof of the building at 389A Worcester Street during the 22nd February, 2011 earthquake. Extensive damage occurred to the Worcester Street façade and to the east wall. Examination of photographs taken after the 22nd February, 2011 earthquake (Refer Appendix 3) establishes that the failure of a substantial portion

of the west wall and parapet in the 22nd February, 2011 earthquake was an out of plane failure of the wall, primarily above first floor level. While the south end of the wall remained standing, it is evident that a substantial portion of the wall above first floor level rotated at or near the first floor support and fell onto and through the roof of the adjoining single storey building at 389A Worcester Street. It appears that the chimney may have contributed to the failure.

The code lateral load coefficient for a first floor 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 indicate that a sound 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 Christchurch 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 above figures indicate that the west wall may not have survived the Canterbury earthquake sequence even if the façade had been adequately secured at roof level.

In a poorly secured condition, failure of the wall was almost inevitable in the severity of shaking that occurred in the 22nd February, 2011 earthquake.

Issues Arising from Review

Upgrading of un-reinforced masonry buildings

The building at 391-391A Worcester Street had remained in a relatively original condition up until the recent earthquakes. The building suffered damage in the 4th September, 2010 earthquake. The building suffered more significant damage during the 22nd February, 2011 earthquake with significant sections of the east, west and Worcester Street walls collapsing outwards.

The damage that occurred to the building in the Canterbury earthquake sequence demonstrates the risk that un-reinforced masonry buildings pose to the occupants of the building, occupants of adjoining buildings 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 relies on territorial authorities adopting and implementing meaningful programmes 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.

Despite having applied for and obtaining the powers to require owners of un-reinforced masonry buildings to upgrade their buildings, the Christchurch City Council had apparently not assessed the building. 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 22nd February, 2011 earthquake. It is still unfortunate that the Christchurch City Council did not require building owners to remove or secure the parapets to 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. There are other areas in New Zealand that need to adopt an active policy on the securing and strengthening of earthquake prone buildings if an adequate level of public safety is to be achieved in their communities.

Protection of adjoining properties

Tragically the Canterbury earthquake sequence has highlighted the danger to the public and adjoining properties of inadequately restrained un-reinforced masonry walls. The 22nd February, 2011 earthquake demonstrated the need for greater caution in the occupancy and public access in the vicinity of unsecured un-reinforced masonry buildings following a significant earthquake.

In the absence of strengthening, the failure of many un-reinforced masonry walls was almost inevitable given the severity of shaking that occurred on 22nd February, 2011.

There is a need to adequately secure the upper level walls of un-reinforced masonry buildings, particularly the parapets and 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, walls, facades and other elements that have the potential to cause loss of life in public spaces and adjoining buildings in a significant earthquake.

Rapid Assessments

No Rapid Assessment-Level 1 was undertaken on the building following the 4th September, 2010 earthquake despite the building having suffered a partial failure of the street façade and other damage. While there are resourcing issues in undertaking Rapid Assessment-Level 1 inspections of all un-reinforced masonry buildings in the period immediately following a significant earthquake in a large metropolitan area, there is concern that such an assessment had not been undertaken on a visibly damaged building within a 6 month period.

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.

The hazard that un-strengthened un-reinforced masonry buildings poses in the period of increased seismicity that occurs following a significant earthquake would justify the territorial authority assigning the a red placard to all un-strengthened un-reinforced masonry buildings and buildings which are located within the fall zone of such buildings. It is suggested that occupancy of the building and public access within and beyond the safe fall zone of the exterior walls or other hazard would then only be permitted once the owner has provided an assessment from a Chartered Professional Engineer that the building achieved minimum strength criteria nominated by the territorial authority.

Co-ordination of assessments

The building was not inspected as part of the Civil Defence Rapid Assessment process as it was outside the Christchurch CBD. The building was however inspected by several engineers and the EQC assessor.

The EQC assessor's assessment of the building was that the building was in danger of collapse and that the 9 metre double brick walls were unstable. While this assessment appears to be at variance with the other assessments (however it appears to have been the only assessment after the Boxing Day earthquake), the opinion raises serious concern over the safety of the building and the appropriateness of the building and the adjoining buildings being occupied. Such opinion should not, in our opinion, be retained within the Earthquake Commission files.

Public safety requires that, in the event of any party undertaking an assessment identifying that the condition of the building differs from the current status of the placard, or lack of a placard displayed on the building, they notify the territorial authority.

Report Prepared By:-

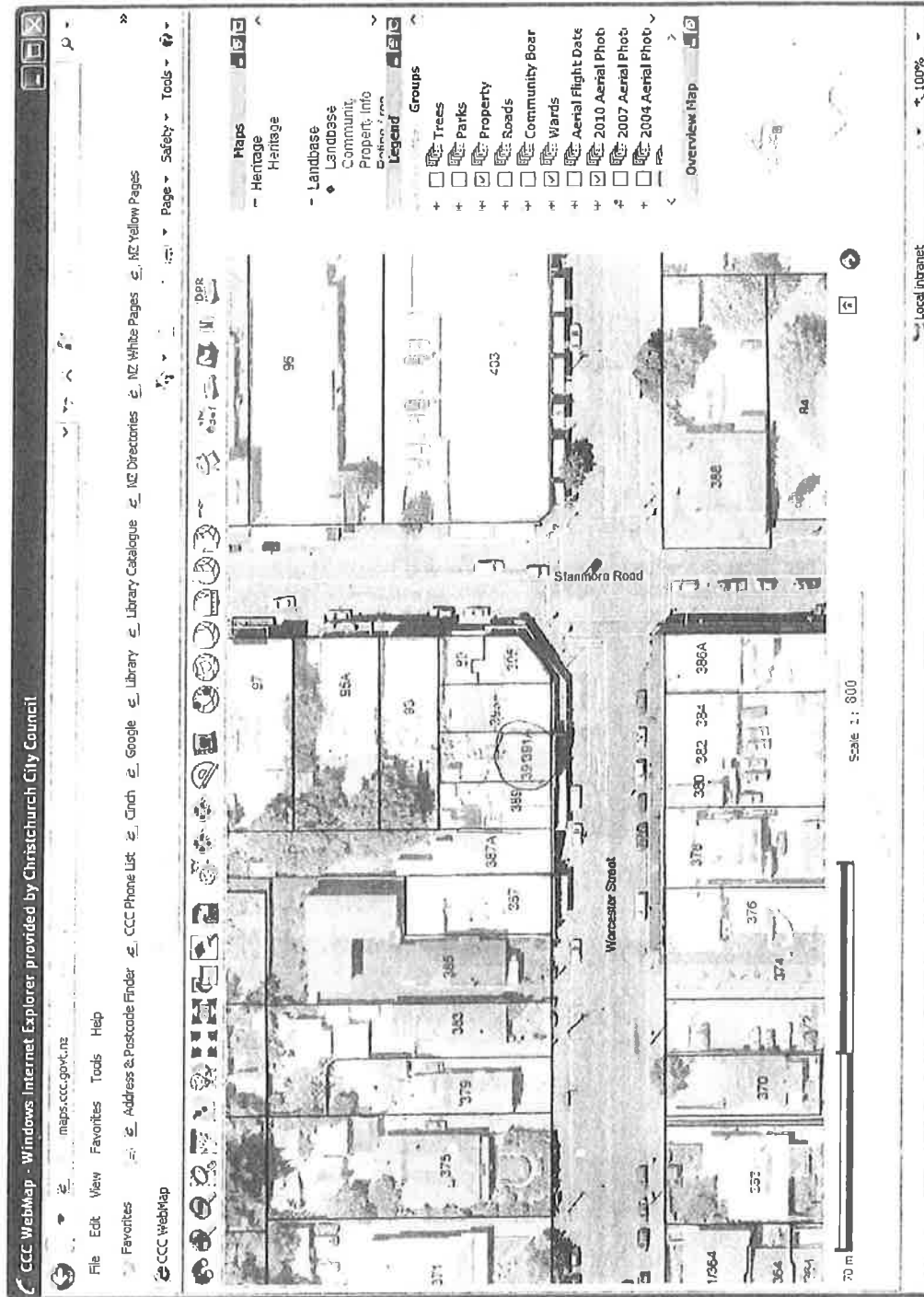
Peter C Smith
BE, FIPENZ, CP Eng IntPE
Director

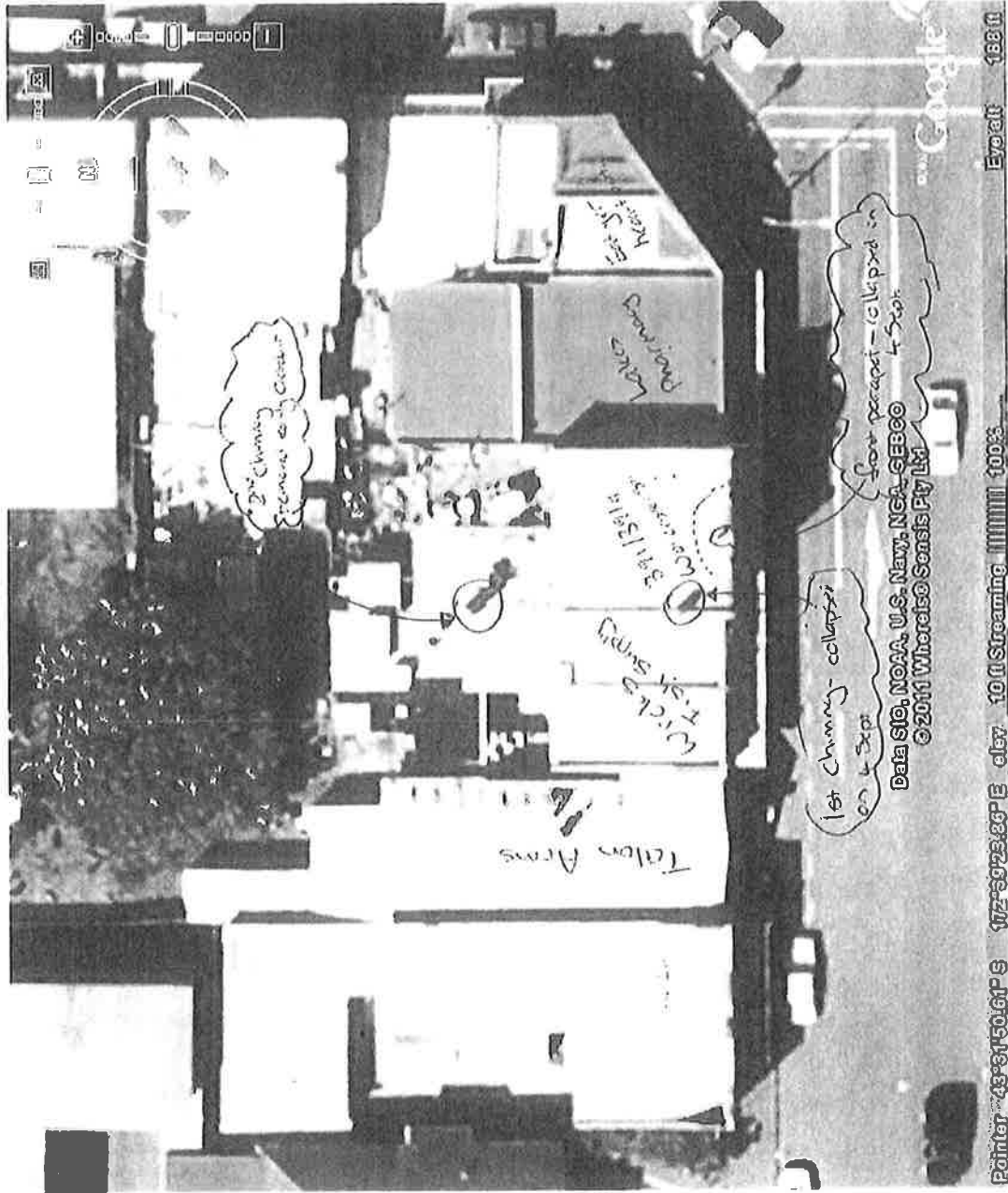
Report Reviewed By:

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

APPENDIX 1

Site Plans





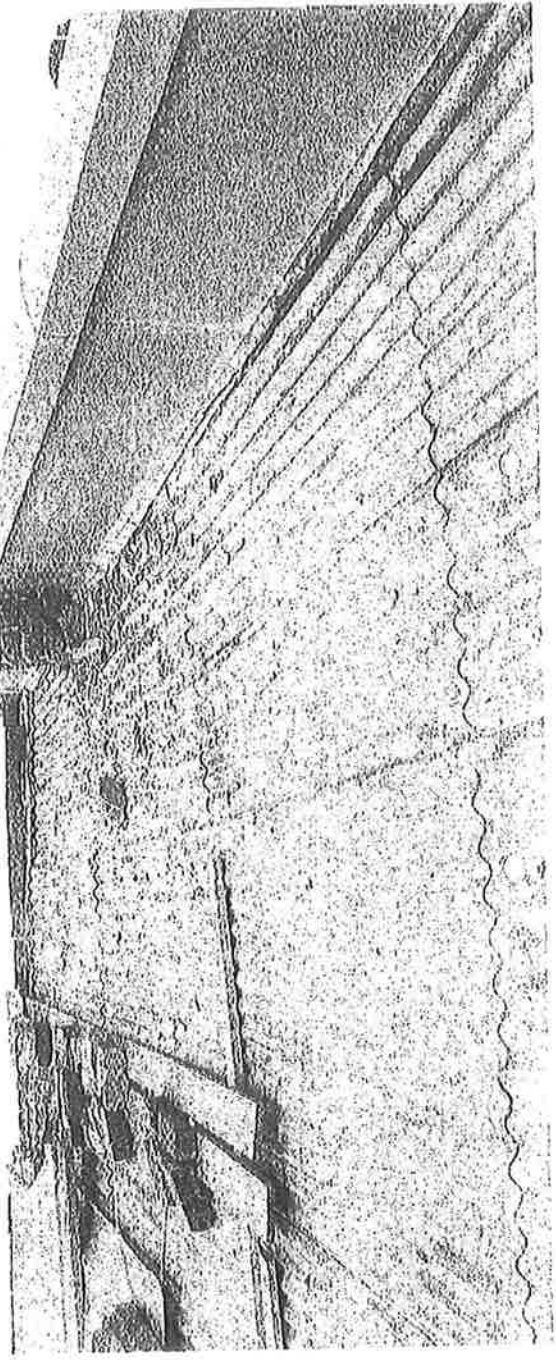
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APPENDIX 2

Photos after 4th September 2010 earthquake

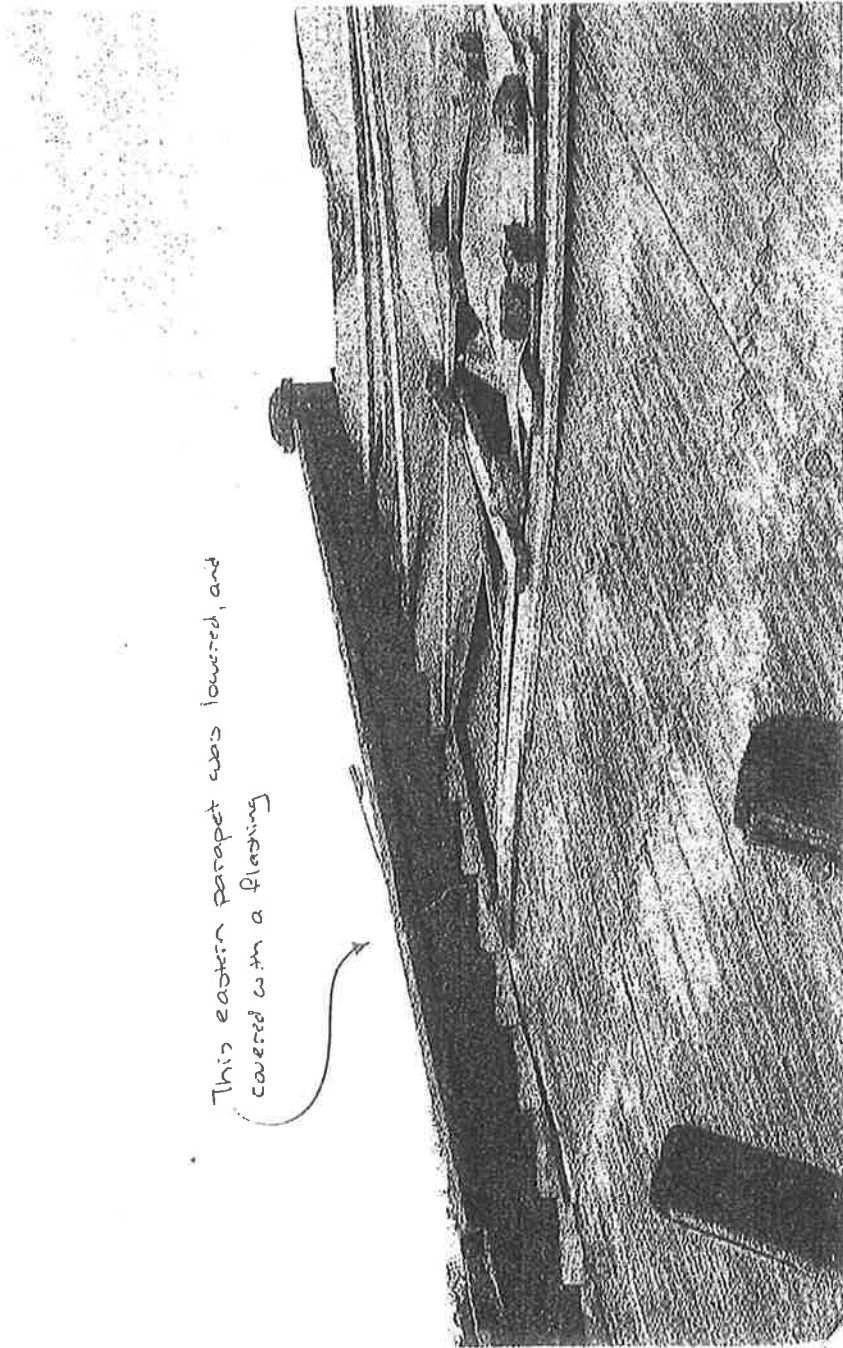
Upper chimney that
fell in the first earthquake

This parapet cap was
cutting when we arrived
on site



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5280

cutting when we arrived
on site



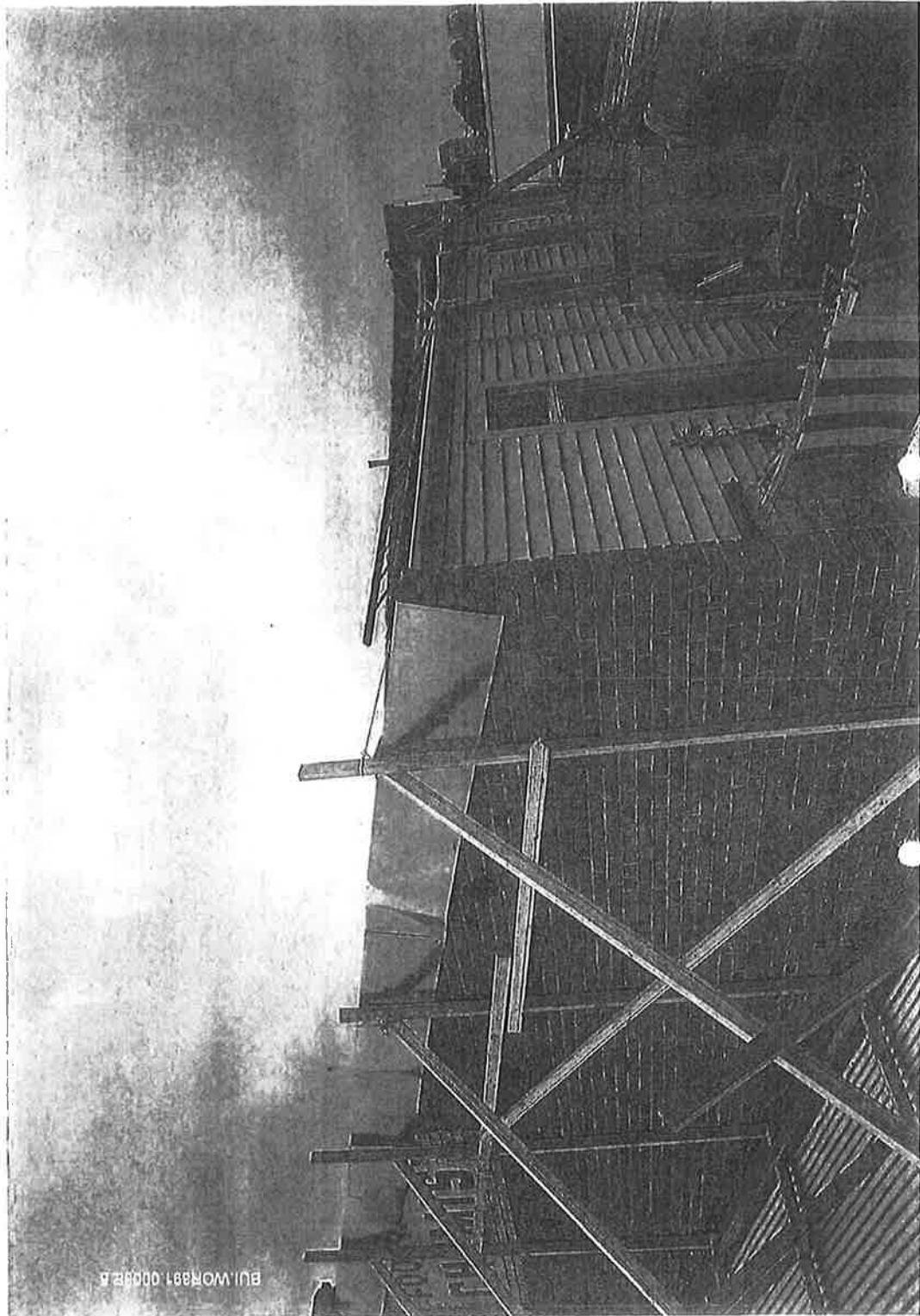
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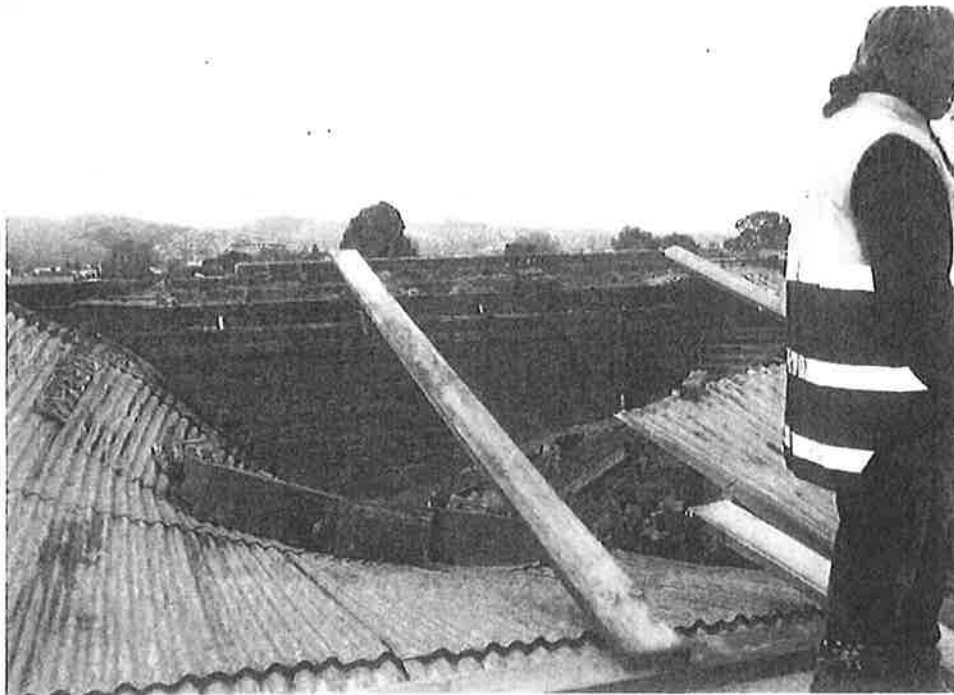
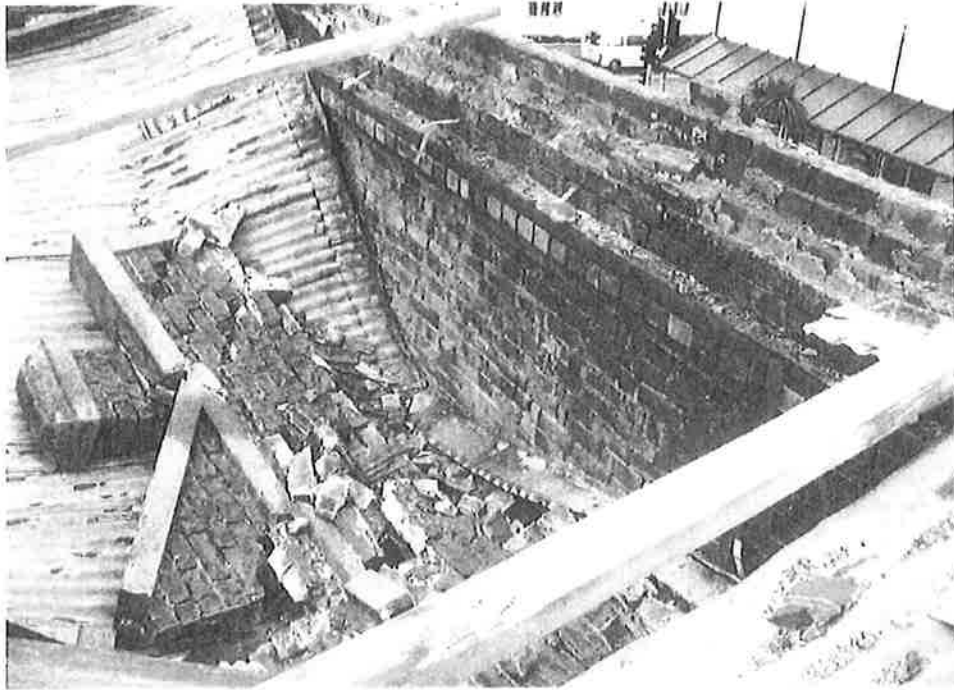
Annex 2



Photo 2 : After the Sept 04, 2010 quake.



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APPENDIX 3

Photos after 22nd February 2011 earthquake

391-391A Worcester St

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Annex 3



Photo 3 : After the Feb 22, 2011 quake.

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Worcester 391 (WICKS)



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Related Docs:

Photos of damage to 389A Worcester Street following 22nd February, 2011 earthquake

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Annex 4

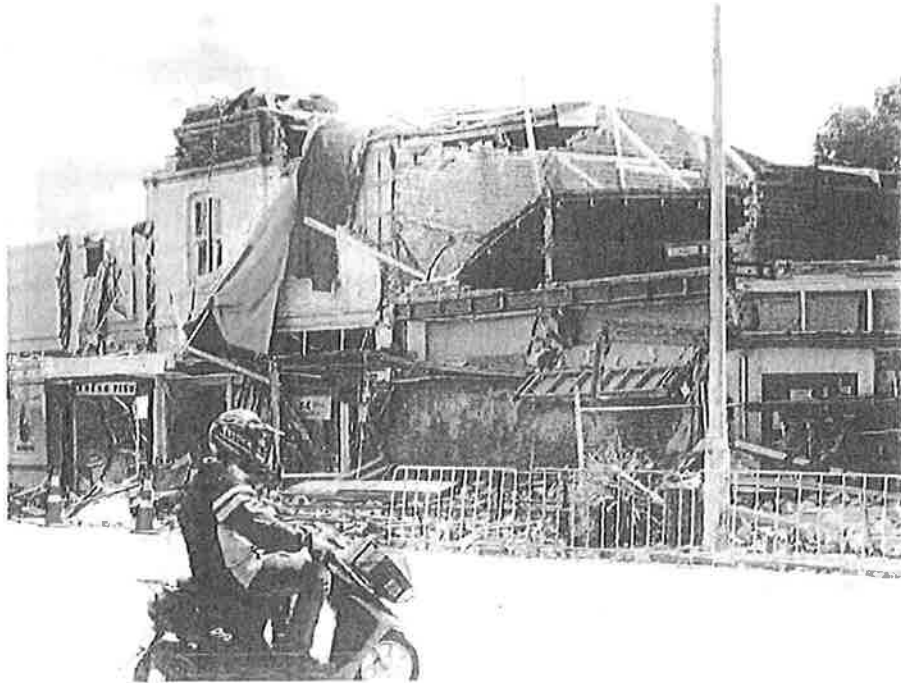


Photo 4: Block of Worcester St shops (from Stanmore Rd end).

