

The Performance of Unreinforced Masonry Buildings in the 2010/2011 Canterbury Earthquake Swarm



Figure 5.15 137 Manchester Street, pull out of the canopy supports

5.4 Clay brick URM building that have been partially or fully demolished

5.4.1 192 Madras Street

This building was designed by the Christchurch architectural firm of England Brothers and was constructed in approximately 1918-1919 on a narrow plot on the east side of Madras Street (see Figure 5.16). The building was not listed with the New Zealand Historic Places Trust but had significant historical and social significance as the original headquarters of the Nurse Maude Association. The building was gifted to the Nurse Maude Association and Nurse Maude herself lived in the building's upstairs flat and died in the property in 1935. The building was turned into office space in the mid 1990s (Christchurch City Council, 2010).



(a) cracking through top spandrel



(b) in-plane diagonal cracking through top spandrel

Figure 5.16 Performance of 192 Madras Street (images taken post-September 2010)

The building had a footprint of approximately 8.8 m by 27 m, with one heavily perforated wall located on the western side (facade) and the other three walls having minimal perforations. The construction was unreinforced masonry with wooden diaphragms and a lightweight roof. The external walls were solid load-bearing masonry and stepped

The Performance of Unreinforced Masonry Buildings in the 2010/2011 Canterbury Earthquake Swarm

from three leaves to two leaves at the first floor level and to one leaf at parapet level. Diaphragm anchors at the first floor and roof level were installed in 1998, providing some earthquake strengthening, but no remedial strengthening work was applied to the facade wall.

Comprehensive damage was visible to the facade wall following the 4 September 2010 earthquake, with the spandrel panels at the first floor and roof level having extensive cracking, both vertically and diagonally. There appeared to be some movement of the facade at the diaphragm level in the horizontal direction perpendicular to the plane of the wall. The side walls suffered diagonal shear failures that were visible internally, extending into the stairway wells. The parapet remained attached, as it was supported to some extent by masonry columns that were an extension of the side walls. A diagonal crack extended from the intersection between the top east corner of the side wall and the masonry column diagonally down (see Figure 5.16(b)), indicating possible rocking of the parapet block out-of-plane.

5.4.2 Joe's Garage Cafe, 194 Hereford Street

At the time of construction in the 1920's, 194 Hereford Street was the end building in a row of two storey buildings. The building was a two storey isolated URM building most recently occupied by Joe's Garage Cafe and Miles Construction, and was isolated from the neighbouring building by a seismic gap (see Figure 5.17(d)). The original structural system consisted of load bearing external URM walls, with timber diaphragms and a concrete lintel beam running the full length of the building on the Hereford Street and Liverpool Street sides. The street-facing facade walls were perforated URM walls whereas the rear of the building consisted of stiff solid shear walls. The building had a sloping roof and the parapet height varied from zero to about 1 m at the side adjacent to the neighbouring building. From preliminary scratch tests it was established that a lime based weak mortar having coarse aggregate was used in the original construction.

The Performance of Unreinforced Masonry Buildings in the 2010/2011 Canterbury Earthquake Swarm



(a) Exterior view



(b) Steel moment frame



(c) Highlighted crack location at the rear of building



(d) Reduction of seismic gap

Figure 5.17 Joe's Garage Cafe (images taken post-September 2010)

The building was seismically retrofitted in 2004 using large steel portal frames oriented in the transverse direction of the building, spaced at approximately 4 m centres as shown in Figure 5.17(b). The building floor plan is shown in Figure 5.18. Diaphragm strengthening was not observed in the interior of the building.

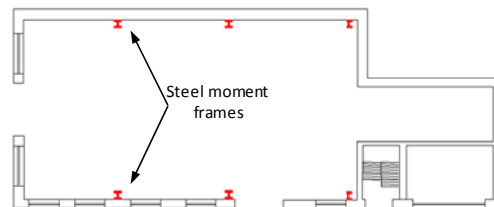


Figure 5.18 Floor plan of Joe's Garage Cafe, showing retrofit

5.4.3 Welstead House, 184-188 Manchester Street

Welstead House was originally constructed in 1905 and was a corner building located at the intersection of Manchester Street and Worcester Street. The building was designed in Edwardian Baroque style by architect Robert England with an 800 m² gross floor area (Rothschild, 2010). The building was occupied by seven tenancies in total, and was a

The Performance of Unreinforced Masonry Buildings in the 2010/2011 Canterbury Earthquake Swarm

standalone two storey clay brick URM building with a regular rectangular plan and no vertical irregularities. A photograph of the building prior to the 4 September 2010 earthquake is shown in Figure 5.19.



Figure 5.19 Welstead House, 184-188 Manchester Street, before the 4 September 2010 earthquake



(a) Corner view

(b) Side view, showing steel anchors

Figure 5.20 Welstead House, 184-188 Manchester Street, after the 4 September 2010 earthquake

The roof of the building was constructed in three gabled sections, with the parapet enclosing the roof gables and estimated to have a height of 1.6 m. The wall thickness was three leaves, increasing to four leaves at the parapet. The parapet was secured by a single through anchor plate at the apex of each roof gable (i.e. a total of three anchors on the Manchester Street side). A concrete frame was placed at the bottom floor level to allow for large open shop fronts.

The building experienced a complete out-of-plane collapse of the street front corner facade walls (see Figure 5.20(a)). Anchors in the gables did not provide sufficient restraint, as they remained in the timber roof structure following the earthquake as shown in Figure 5.20(b). Steel anchor plates which were observed along the Worcester Street roof were positioned between the masonry leaves. These anchors remained in the timber roof structure, indicating that insufficient out-of-plane restraint was provided. Due to excessive damage and safety considerations the building was demolished following the 4 September 2010 earthquake.

The Performance of Unreinforced Masonry Buildings in the 2010/2011 Canterbury Earthquake Swarm

5.4.4 Caxton Press, 113 Victoria Street

The Caxton Press building was thought to have been constructed in the 1870's. The building was a two storey isolated building that was surrounded on two sides by a reinforced concrete block building as shown in Figure 5.21(a). The Caxton Press building was formerly a bakery, with the baker's oven still intact behind the modern plasterboard walls. The side walls are solid two leaf walls constructed using English bond, which has alternating header and stretcher courses, whereas the facade wall has no visible header courses.

The ground floor street-front was open, accommodating the placement of circular cast-iron columns to support the upper storey walls. The timber diaphragm joists span parallel to the facade wall, with the floorboards running perpendicular.



(a) Exterior view



(b) facade wall pulled away from the side walls

Figure 5.21 Caxton Press building at 113 Victoria Street (images taken post-September 2010)

The Caxton Press building was extensively damaged during the Darfield earthquake and the subsequent aftershocks. From external observation, the parapets on the facade wall had collapsed, the top of the gabled side walls had failed due to out-of-plane loading seen in Figure 5.21(a), the perforated facade wall had developed extensive shear cracks through the spandrel over the openings, and the facade wall had pulled away from the side walls due to insufficient anchorage, as shown in Figure 5.21(b). Furthermore, pounding was evident from cracking on the side walls adjacent to where the new concrete block building butted up to the URM building. On internal inspection, evidence of diaphragm movement was apparent as indicated by displacement of the floor boards and the 15 mm displacement of the bricks in the side walls.

The Performance of Unreinforced Masonry Buildings in the 2010/2011 Canterbury Earthquake Swarm

The building owner, who was standing outside the building at the time of the first major aftershock, recalls seeing the brick wall move in a wave pattern, which indicates possible diaphragm movement and weak cohesion between the bricks and mortar. The building was demolished following the 4 September 2010 earthquake.

5.4.5 Cecil House / Country Theme Building, 68-76 Manchester Street

The Cecil House / Country Theme building was an “L” shaped corner building located at 68-76 Manchester Street, on the corner of St Asaph and Manchester Streets (see Figure 5.22(a)). The building had two stories, was constructed in 1877 in the neo-classical style, and was believed to have significantly contributed to the heritage value and character of the Commercial Urban Conservation Area (Opus International Consultants, 2005).



(a) Corner view showing parapet collapse

(b) concrete beam on the ground

Figure 5.22 Cecil House / Country Theme Building, 68-76 Manchester Street (images taken post-September 2010)

The front façade of the building was a three leaf clay brick URM wall, with two leaf thick parapets located along the street-facing perimeter. The parapet had a poorly reinforced (approximately 6 mm round bars at each corner) concrete beam on top.

The most apparent earthquake damage was the toppled parapets around the street frontage as illustrated in Figure 5.22(b), with a lightly reinforced concrete beam on top of the parapet providing insufficient restraint. Falling parapets landed on the canopies below, overloading the supporting tension braces that caused a punching shear failure in the masonry wall and subsequent canopy collapse. The connections appeared to consist of a long, roughly 25 mm diameter rod, with a round steel plate (about 10 mm thick) at the wall end that was approximately 150 mm in diameter.

No evidence of through anchors connecting the roof diaphragm to the wall structure was observed. Some in-plane damage to the far end of the building along Manchester Street was evident, mostly consisting of cracking through the spandrel and some horizontal cracking through the piers.

The building was partially demolished following the 22 February 2011 earthquake.