

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



(a) Front elevation



(b) Side elevation

**Figure 3.15 Successful wall-floor and wall-roof diaphragm anchorages**



(a) Extensive vertical cracking above window openings



(b) Vertical crack above window opening



(c) Vertical crack through spandrel



(d) Diagonal crack extending from window opening

**Figure 3.16 Examples of in-plane wall damage above window openings**

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### 3.1.10 Partial wall failures

Another interesting feature of this earthquake is the observation of walls that only partly failed, allowing for identification of the specific failure mode at its onset. Several excellent examples are described below. The first of these is a 2-storey URM building on Ferry Road (see Figure 3.17) where the front, street facing, wall of the building had started to fail out-of-plane despite the presence of wall-roof diaphragm anchors. As is shown, the anchors were on the verge of pulling through the masonry wall. Internal inspection of the building revealed that the front wall had separated from the long side walls of the building and moved approximately 50 mm towards the road with respect to the ceiling/roof diaphragm (Figure 3.17(d)). It is believed that due to the nature of strength degradation of the brickwork at the onset of a punching shear failure, the anchorage has effectively failed and offers little residual resistance against further shaking. The only reason the wall did not completely collapse is probably due to the earthquake not imposing sufficient displacement on the wall after the anchorage failure.



(a) Building overview



(b) Detail of partial anchorage failure



(c) Onset of anchorage failure



(d) Internal view showing wall separation

**Figure 3.17 Wall-roof anchorage failure and partial wall failure**

A similar style of partial failure was observed in another building on Ferry Road (Figure 3.18(a)) but the authors were only able to observe the building externally. It should be