ON THE GROUND IN CHRISTCHURCH

The 6.3 magnitude earthquake that struck Christchurch on 22 February 2011 and the many aftershocks have been an enormous test of the performance of buildings. BRANZ structural engineers provide some initial thoughts on how houses performed.

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An important part of the immediate post-earthquake response phase in Christchurch was to get people back into their homes as quickly as possible. Before this could happen, though, damaged houses needed to be inspected by experienced building professionals. The full complement of BRANZ structural engineers was in Christchurch assisting with Operation Suburb, which wound up on 5 March 2011.

Key observations

From what BRANZ engineers saw, timber-framed houses generally performed well, and the collapses were primarily due to ground instability.

Concrete block wall construction had variable performance. Failures here were from the era when walls did not have reinforcing steel.

Many failures in older buildings could be directly attributable to a lack of maintenance, for example, where there were rotting foundations.

One particular issue in modern buildings was broken glazing, as new houses are often quite flexible. A number of houses were deemed unsafe to be reoccupied – not due to imminent collapse but because of the hazard of overhead glass falling onto occupants.

Performance of different components

Specific components of house construction were inspected. This allowed BRANZ engineers to observe how different construction systems stood up to the seismic loads.

INTERNAL LININGS

Plasterboard is widely used as internal linings in homes in New Zealand. Widespread diagonal cracking and joint cracking were evident, and there was some rupturing of plasterboard sheets from shaking and ground subsidence.

Plasterboard ceilings generally performed well and provided good diaphragm action to transfer lateral earthquake loading through to the bracing walls.

Not surprisingly, the older lathe and plaster linings performed poorly, but, as expected, no evidence was seen of this contributing to more

Unreinforced clay brick chimney collapse, while timber-framed house construction remains intact.

Damage to monolithic cladding.

Cracking of cement-based sheets.

general collapse of houses because there was generally diagonal timber bracing in the framing behind.

EXTERIOR CLADDINGS

EIFS (exterior insulation finishing system), which generally consists of polystyrene and a plaster coating, performed well. Where cracking and so on has occurred, it is expected that repairs can be easily carried out in place without removal of the cladding.

Fibre-cement sheet is a common cladding, and because it is generically a brittle material by nature, examples of sheet failures were observed.

Weatherboards performed well, with the damage being paint cracking to horizontal joints.

There was extremely variable performance where bricks were used. At one end of the spectrum, unreinforced loadbearing masonry such as double-brick construction performed generally very poorly with, not unexpectedly, widespread failures occurring.

Modern clay brick veneer appeared to generally behave quite well, but concrete bricks (for example, Summerhill stone and Oamaru stone) and concrete block veneers, even with modern ties, still peeled off the houses.

ROOF CLADDINGS

No real problems were observed by BRANZ staff with long-run metal roofing or pressed metal roof tiles.

Concrete roof tile damage varied. This ranged from no damage, through to almost complete loss of the tiles. One specific aspect of the earthquake ground motion – a high vertical acceleration component – could well have been the factor contributing to the damage suffered by concrete roof tile systems. The presence, or absence, of wire ties connecting the tiles to the roof framing was probably a contributing factor as well.

Clay roof tiles were nearly always dislodged to varying degrees, with many roofs significantly damaged. In one house (see below), the tile roof is pretty well intact other than at a party wall where the inertia of the heavy tile roofs on either side overcame the roof space lateral bracing capacity and fractured at this junction.

Significant damage where tiles were not adequately tied to the battens. Some extra tile removal has also been undertaken.

FOUNDATIONS AND FLOORS

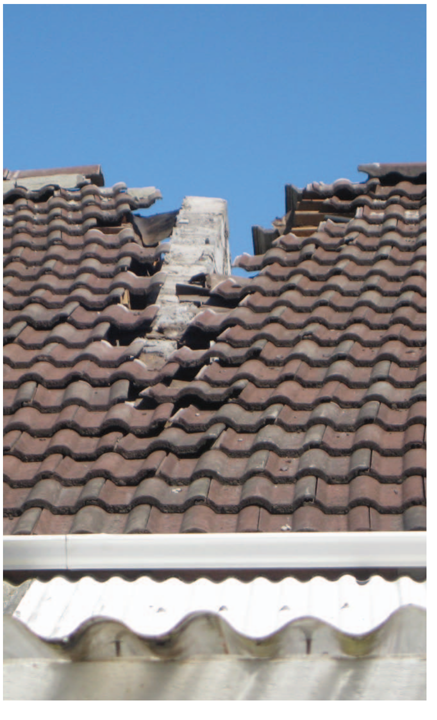
There were widespread failures of foundation walls that had little or no reinforcing steel. There were also many examples of foundation wall-to-slab failures where the connection between the wall and slab failed or where sliding of the slab occurred because there were no mechanical fixings present.

There was little evidence of floors falling off piles, often due to the presence of continuous perimeter foundation walls.

In the hill suburbs, there were quite a number of mortared rock foundations that were very brittle, and significant cracking occurred, particularly if the superstructure was heavy.

No evidence was seen of pole failure/fracture. However, there were several cases of poles leaning after being pushed by soil slumping against the top of the slope on which the poles were installed.

Collapse of double-skin unreinforced clay brick wall.



Concrete tile roof fracturing at party wall junction.

Extensive damage to unreinforced concrete foundation wall. Note the fragments of clay brick as aggregate.