

LIGHT STEEL-FRAMED HOUSE GETS THE EARTHQUAKE TEST

Tests show that brick veneer steel-framed houses should perform very well in earthquakes.

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Light steel framing has gained in popularity, with New Zealand companies being a leading supplier of roll forming technology. The high-strength thin-walled steel used in Australasian construction is unique, which means that none of the seismic testing undertaken in the northern hemisphere using thicker lower-strength steel is directly applicable.

Small-scale tests the standard

Historically, the seismic performance of wall ties has been established from small-scale tests conducted according to the requirements of AS/NZS 2699.1:2000 *Built-in components for masonry construction – wall ties*. The test procedure involves using prescribed levels of displacement in both the in-plane and out-of-plane direction.

The results of these tests have led to concerns over the seismic performance of brick veneer attached to light steel framing. But how realistic are these tests compared to a real earthquake?

House built for earthquake testing

To investigate this question, full-scale shaking table tests were undertaken in April 2009 by the National Association of Steel Framed Housing (NASH) at the University of Melbourne.

The testing was undertaken under the direction of Professor Emad Gad, with technical support being provided by Associate Professor Charles Clifton of the University of Auckland and NASH (Australia).

Graham Rundle of Redco (NZ) Ltd designed the test house. It measured approximately 2.6 × 2.8 m in plan and 2.4 m in height. It had a light steel frame with brick veneer exterior cladding and plasterboard interior lining. The steel frame was manufactured from 0.75 mm thick G550 lipped C-sections. The bricks were standard 70 Series with Type B brick ties.

The ties were screwed to the flanges of the studs through a standard 40 × 10 mm thick thermal break. The front and side walls were separated at the corners, in order to simulate long brick veneer walls. A roof slab weighing 1,500 kg was placed at the top and was supported by the frame to simulate the equivalent mass from a house roof. The result was that the test house exhibited the same dynamic characteristics as those of a typical full-scale single-storey brick veneer house. It had a fundamental natural frequency prior to earthquake shaking of approximately 6 Hz.

Small and large earthquakes simulated

The objective was to assess the performance of light steel framing with brick veneer walls when subjected to out-of-plane earthquake loading,



Test house on shaking table prior to test.

having been previously subjected to in-plane loading (which has the potential to weaken the veneer/tie/stud system).

The magnitude of the earthquake loading was determined in accordance with defined performance levels under the earthquake loadings standard, NZS 1170.5:2004 *Structural design actions – earthquake actions – New Zealand*, so that the performance achieved in the test could be directly related back to the design level for New Zealand earthquakes.

The house was subjected to earthquake motions based on the El Centro 1940 North-South record, scaled to generate levels of earthquake loading ranging from serviceability to the maximum considered. To ensure that appropriate levels of loading were applied, the target shaking levels were verified by measured table accelerations.

Performed extremely well

The house performed extremely well, with the maximum considered levels of shaking only causing minor cracking to the plasterboard and brick veneer walls (even though, at this level of loading, major loss of the veneer walls is acceptable).

The house was then subjected to even more severe shaking. It did not suffer serious damage up to and including 2.6 times El Centro, with no bricks being lost from the out-of-plane walls. This is an extremely good performance given that the house had already been subjected to seven high-level earthquakes. The testing was terminated after a final shake equivalent to 2.7 times El Centro (1.57 times the maximum considered) because the capacity of the shaking table had been reached.



Permanent deformation of brick ties at end of tests.



Internal lining damage at maximum load.

The test is considered to be representative of brick veneer steel-framed construction in New Zealand. Due to its excellent performance under this onerous earthquake testing programme, it is expected that this form of construction should perform well in the most demanding design seismic conditions in New Zealand. Also, it appears that the small-scale tests given in AS/NZS 2699.1 are not entirely appropriate for this form of construction.

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