Canterbury Earthquake Recovery Project Supplementary Information

HOW TO STABILIZE LIFTED HOUSES SAFELY TO FACILITATE THE REPLACEMENT OF FOUNDATIONS

This document has been prepared by Patterson Contracting Otago Ltd on behalf of the New Zealand Heavy Haulage Association to promote safe work practice in the Construction Industry

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"The Sign of a Professional"

BURIED CONCRETE BLOCK "DEADMAN" METHOD TO PROVIDE SUPPLEMENTARY BRACING FOR LIFTED TIMBER FLOOR HOUSES IN THE CANTERBURY SEISMIC AREA

(RE: DEPARTMENT OF LABOUR FACTSHEET – LIFTING EARTHQUAKE AFFECTED BUILDINGS IN CHRISTCHURCH)

INTRODUCTION

The recent earthquakes have impacted the Canterbury Region and its people. A significant number of houses will need to be lifted in order to have their foundations replaced. This document is intended specifically for the Canterbury seismic area to help minimize risk to people undertaking this work by providing additional bracing to lifted houses. In particular:

1. When people are required to work around or (in controlled conditions) underneath the lifted building And :

2. If the building is to remain lifted for a prolonged period of time for example when a reinforced concrete block foundation is to be constructed.

3. On sloping sites where part of the lifted building will be high off the ground

This temporary bracing system is an acceptable solution which is based on earthquake bracing values used in the current New Zealand Standard for light timber framed buildings (NZS3604 2011) and specifically the braced pile calculations for timber floored houses (Section 6.8). These bracing systems have performed well in houses during the recent earthquakes (refer Sources) and provide approximately 15 bracing units (bu) per square metre (m^2) of dwelling floor area. Twelve kilonewton (kn) fixings are commonly used to achieve this and work effectively when spread throughout the timber floor diaphragm of the house. (20 bu = 1kn). Refer to engineering notes for details.

COMPONENTS

A similar result may be achieved in a temporary bracing system using 3 components:

1. Ground anchor points

   These are required around the perimeter of the building and in particular the corners (refer diagram in engineering notes). An existing driveway or concrete structure may be suitable providing that a 12kn anchor point can be achieved. Where this is not possible buried 1000kg concrete blocks ("deadmen") may be used with each block capable of sustaining two 12kn anchor points. Alternatively a 12kn anchor point could be achieved by boring a suitable sized hole and pouring concrete anchors in-situ.

2. House anchor points

These may be achieved by using an exterior ribbon board screwed directly into the perimeter of the floor and fitting threaded rod through the external ribbon board and bolting directly into floor joists further inside the floor (refer photo). This will help to spread the point load of the anchors throughout the entire floor. Anchor points should be placed around the perimeter of the floor starting in the corners of the house (say 500 in) and then at 8 metre centres along longer walls (refer engineering notes).

3. Ground to house connection

This may be achieved using acroprops fitted at each end with plates which are commonly used to hold pre cast concrete panels (minimum rating 30kn per prop) Acroprops work well in compression and tension and are strong enough to have a good margin for safety.

Please note

The components described are relatively inexpensive and easy to obtain or hire in order to make the temporary bracing system practical however work should only be carried out by, or under the direct supervision of, a suitably qualified or experienced person.

Number of anchor points to use

It is important to use enough anchor points to stabilize the house effectively. This will depend on how big and heavy the house is. Allow one 12kn anchor point for every 10 to 15m^2 of house floor area. Sufficient anchor points must be used to achieve a minimum of 15 bracing units per square metre of floor area (for example a 100m^2 house will require 1500 bu or 6.25 x 12kn (240bu) anchor points). A safety factor incase of structural failure in part of the floor should be considered (for example a 100m^2 house requiring 6.25 anchor points with a safety factor 1.5 will actually require 9.375 (say) ten x 12kn anchor points, ideally 2 in each of the 4 corners and 1 central span along each of the 2 longest walls).

INSTALLATION

Establish site

- Erect fencing and signage to keep the public off site.
- Check electricity is disconnected.
- Implement SSSP.
- Ensure that personnel are suitably experienced, inducted and wear PPE.
- No work should be undertaken on site without first determining how stable the damaged building and surrounding land is. Dunnage may need to be fitted under the perimeter of the building immediately if the existing foundations have been damaged and there is risk of collapse during an aftershock.

Establish anchor points in the ground

If a suitable ground anchor point already exists (such as a heavy concrete driveway) this can be used to secure acroprops. Otherwise:

- Form suitable access onto and around site
- Import to site suitable concrete blocks of at least 1000kg each and 17.5mpa concrete.
- Dig hole.
- Sling concrete block using a rated sling to a suitable fixing point on the block and lift with a machine of appropriate rating.
- Place block in hole and compact soil around it to provide suitable soil bearing capacity as per NZ3604 2011 Section 6.8.
- Establish M12 fixing into block at suitable point for acroprop (for example drill hole with masonry drill and hammer in 1 x 100mm M12 wedge anchor).

Establish anchor points to the house

- Fit 200 x 50 ribbon boards to exterior of floor diaphragm using 100 or 150mm tek screws screwed directly into floor joists, bottom plates and bearers where possible.
- Fit threaded rod through ribbon board and secure to floor joists further inside the floor using M16 rod and 50 x 50 square washers to spread load through the floor (refer photo). Ensure that the joists are free of rot or borer infestation. A dummy joist may be bolted along side the original joist if the original joist has minor deterioration. If part of the floor has deteriorated badly, do not use this as an anchor point.
- A minimum of 2 people should be on site while sub floor work is undertaken if there is risk of the person under the house becoming trapped through building collapse or liquefaction.

Fit acroprops

- Acroprops can now be fitted between the ground and building.
- Ensure that props are correctly fitted and adjusted and are released before the building is raised or lowered.
- Ideally the angle of the prop should be no greater than 45 degrees to the ground which should be allowed for when establishing anchor points.
- Suitable dunnage must be used underneath the house to prevent collapse. Generally stys consisting of wooden blocks or metal tripods are used (refer NZHHA Best Practice Guide for Building Relocation in New Zealand).

PLEASE NOTE

This document is intended as a generic guide and is based on sound engineering practice. No warranty is implied or given as to the performance of any part of the aforementioned stabilization system as its use is outside the direct control of the engineer.

OTHER THINGS TO CONSIDER

Asbestos

- Use a suitably qualified contractor where asbestos cladding needs to be removed.

Ground Stability

- Ensure that the ground has good bearing prior to lifting the house.
- Do not dig foundations too close to stys and undermine them causing collapse.
- Where rain water down pipes have been disconnected ensure that water does not flow directly under the house making the ground soft and de-stabilizing stys.

Steel Beams

- These may be used to increase the span between stys and provide additional support for the lifted house.
- Friction between steel and wood is less than wood and wood so horizontal load may not be transferred as directly between the house and top of the stys during an aftershock.

Tags

- It may be prudent to tag critical components of the temporary support structure "Do Not Remove" in order to prevent inexperienced sub trades from removing them when you are not on site.

SOURCES

1. BRANZ
2. DBH
3. Standards New Zealand

APPENDICES

1. Engineering notes
2. Photos

CH-CH TEMP.
HOUSE BRACING

NOTES TAKEN AT MEETING
23/11/11 - BRENT PATTERSON
- DAVID LITTLETON

NZS 3604 : 2011

BRACED PILE - 120 BU's

1 TONNE CONC. BLK. = .75 m x .75 m x .75 m
BURIED IN GROUND PROVIDES 0.56 m²
BEARING AREA AGAINST SOIL

BRACED PILE FOOTING - 0.45m x .35m x .35 m = .055 m³
APPROX $\frac{1}{7}$ OF 1 TONNE BLK

BEARING SOIL AREA OF 0.16 m²
APPROX $\frac{1}{4}$ OF 1 TONNE BLK

1 TONNE CONC. BLK EQUIV. TO 4 BRACED PILES
OR 480 BU's

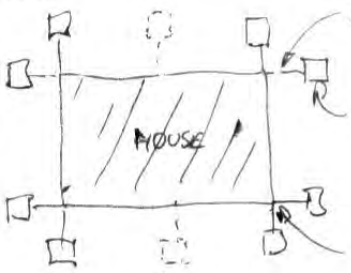
HOUSE IN ZONE 2 CH-CH - HEAVY ROOF
LIGHT FOUNDATIONS
LIGHT WALL CLADDING

ASSUME SOIL TYPE 'E' = SOIL FACTOR = 0.8

REQ 19 BU's/m² x 0.8 SOIL FACTOR
= 15 BU's/m²

FOR 100 m² HOUSE - REQ 1500 BU's
÷ 480
REQUIRE = 3.1 CONC. BLK
(4 IN EACH DIR'N)

BRACING LINES FOR FOUNDATIONS MAX SPACING S
BUT IF DIAPHRAGM FLOOR - PUSH SPACING OUT
TO ~ 12 m



2 m ACROPROP
⇒ 31 kN
x 20
600 BU's/AR

MID ANCHOR
MAY BE NEEDED

CONN. TO HOUSE IS THE