



Sustainable Management of Historic Heritage Guidance Series

Repairing and Rebuilding Historic Chimneys after an Earthquake

Background

Chimneys were a ubiquitous feature of pre-1960 buildings in New Zealand. It was extremely unusual for a domestic dwelling to be constructed without a chimney. The majority of chimneys were built using unreinforced brick masonry. The Canterbury earthquake (4 September 2010), and its subsequent aftershocks, caused significant damage to a high proportion of unreinforced masonry chimneys in the region.

Technology and social factors, such as the availability of cleaner heating devices and a desire of the community to live in a less polluted environment, have made chimneys increasingly functionally redundant and as a consequence many property owners have had their chimney stacks removed over the past half century. The incremental erosion of our chimney stock, combined with the loss attributable to a destructive earthquake, leaves the future of the chimney hanging in the balance.

Chimneys are often vital components of a building's composition and it would be regrettable to lose these architectural elements from the skyline. Not only are chimneys aesthetically pleasing, they serve as tangible reminders of a previous way of life.

The New Zealand Historic Places Trust (NZHPT) strongly recommends that, where possible, chimneys damaged or destroyed as a result of an earthquake, should be repaired, restored or reconstructed in the most authentic manner feasible. However, safety must be prioritised and seismic strengthening may require significant intervention.

No two chimneys, and the damage they have sustained, are identical - nor will one approach be the solution to all the various scenarios. Although repairing or rebuilding a chimney to its original form, using original materials is the most heritage sensitive solution in a conservation sense, in some instances replacement, using lightweight materials, **may** be an option. Each chimney needs to be dealt with on a case by case basis.

Following an earthquake the NZHPT suggest you:

1. Ensure your building is safe:

- (a) **Chimney appears (visually) undamaged**
 - Record (photograph, draw and measure as appropriate) damage even if chimney appears undamaged to the naked eye. Aftershocks may have an unknown effect on the structure.
 - Check the structural integrity of the chimney both above and below roof level.
 - Consider seismically strengthening the chimney to ensure the structure will withstand any future seismic activity. The New Zealand Historic Places Trust (NZHPT) strongly recommends strengthening all chimneys.

For information about conservation principles that inform works such as repairing historic chimneys, see the NZ ICOMOS Charter 2010: www.icomos.org.nz

See also the NZHPT's Sustainable Management of Historic Heritage Guidance Series 'Heritage Provisions for earthquake-prone buildings policies under the Building Act 2004' http://www.historic.org.nz/ProtectingOurHeritage/-/media/Corporate/Files/Submissions%20and%20research/RevisedDraftGuide_Earthquake.ashx

(b) Chimney partially destroyed – bricks missing, displaced or destabilised

- Record remaining structure (photograph, draw and measure as appropriate). Photographing where the bricks fell can provide useful information also.
- Remove bricks which have become detached from the structure (check ceiling cavity).
- Stabilise the chimney shaft by tying, propping or cladding.
- Ensure building is temporarily weatherproof.
- Check structural integrity of the chimney below roof level.
- Ensure all intact bricks (and/or other important building materials) removed from the chimney are stored on site.

Resource consent is required under the RMA from your local authority to demolish or alter any listed heritage building.

Always check with your local authority before carrying out any repair work to heritage buildings.

(c) Chimney destroyed – shaft fallen, possible damage to the chimney breast

- Record damage (photograph, draw and measure as appropriate).
- Remove bricks which have become detached from the structure or those which could imminently fall thereby posing a risk to personal safety (check ceiling cavity).
- In some instances the damage may be so extensive and pose such a risk to personal safety that the building is deemed uninhabitable until remedied.
- Check the structural integrity of the chimney below roof level.
- Check structural roof members have not been affected.
- Where the building is open to the weather, make as temporarily weatherproof as soon as possible.
- Ensure all intact bricks (and/or other important building materials) removed from the chimney are stored on site.

2. Repairing/rebuilding/replacing a damaged chimney

- All work must comply with the Building Act 2004.
- Given the risk inadequately repaired chimneys can pose, skilled and professional building practitioners should be used.
- Do not rush building work. All options should be carefully considered before building begins. Generally it takes a considerable amount of time for EQC and insurance companies to assess the property and to pay out claims.
- A structural engineer will be required in most instances to: (a) determine the reason for the chimney failure and (b) to provide

a design to strengthen the chimney against future earthquake damage.

- The NZHPT recommends strengthening all chimneys. The NZHPT has prepared a draft guide for earthquake strengthening of heritage buildings:
<http://www.historic.org.nz/en/ProtectingOurHeritage/ConsultingOn.aspx>
- All work should be done in accordance with the ICOMOS New Zealand Charter (2010):
http://www.icomos.org.nz/NZ_Charter.pdf (Guidance can be provided by NZHPT and Council staff).

REPAIRING (using original or like materials)

Repair will be appropriate when the chimney has sustained minimal damage and the structure is relatively intact.

- When repairing a chimney it is important to preserve the original appearance so much as possible. Where feasible, original materials should be used or if this is not achievable identical or closely similar material should be utilised.
- The repair of mortar joints should be carefully considered.
- The type of mortar used will depend on the age of the chimney and when/if any repair work has been undertaken.
- Lime-based mortars (crumbly in consistency and paler in colour) were most often used on buildings pre 1900. Cement-based mortars (harder and more impervious in consistency and darker in colour) have typically been used in buildings post 1900. Each mortar type has inherent strengths and weaknesses. Lime mortars behave very differently to cement mortars and it is vital that the mortar used is consistent throughout the structure.
- New mortar joints should not be stronger than the bricks. In the event of future earthquakes it is preferable that the mortar joints give way before the bricks fail. This encourages “stepped cracking” of the brick structure rather than the entire unit failing.
- **Brick Chimneys** - Original bricks should be reused wherever possible. Physically damaged, or severely weathered, bricks should be discarded. Bricks must be cleaned of all mortar and mortar dust. Immediately prior to relaying the bricks should be pre-wetted to ensure the new mortar re-adheres to the brick surface. Caution should be exercised when reusing bricks from chimneys with unlined flues - bricks which lined the inner surface of the chimney should not be reused because their performance may be compromised due to the accumulation of salts from flue gasses. Experienced brick masons should be

Further information about repairing historic brickwork is available from the NZHPT:
Ian Bowman, *Historic Brick Structures*, Conservation Bulletin No.2, NZHPT, 1992

engaged to repair chimneys as they will be fully conversant with various mortars and how reused bricks will perform when used in a rebuilt structure.

REBUILDING

Rebuilding is appropriate where the chimney has sustained serious damage. For example, when a number of bricks have fallen or the structural integrity has been compromised to such an extent that the chimney needs to be carefully taken down to a level where it is structural stable and reassembled back to the original form.

- When restoring a chimney it is important to preserve the original appearance so much as possible. Where feasible original materials should be used or if this is not achievable identical or closely similar material should be utilised.
- In order that the chimney is able to withstand future seismic events a new internal structure may be required. Various options are available. The appropriate solution will depend on a number of variables, i.e. height of chimney, degree of damage and whether the chimney will be functional or not.
- If the chimney is to be functional a triple skinned flue may be inserted – this allows functionality while also providing structural strength.
- Threaded tension rods or wires may be anchored at the base of the fireplace and drilled to run the entire height of the chimney.
- A plywood diaphragm surrounding the chimney shaft in the roof space may be necessary to provide lateral strength.
- A lightweight steel frame may be utilised. Affixed to the frame is a suitable substrate to which the original bricks are affixed. Hebel™(lightweight aerated concrete panel), Hardiebacker™ or marine plywood are two of the substrates available.
- **Brick Chimneys** - Original bricks should be reused where possible. (See final bullet point under the section titled 'Repairing' above).

REPLACING (Using lightweight materials)

Replacement is considered the least desirable option from a heritage conversation perspective. However, there will be occasions when it may be necessary to reproduce discrete elements within a building which have been lost or destroyed due to a destructive event (i.e. earthquake). Using lightweight replacement materials would be unlikely to be an acceptable option for buildings with the highest heritage value. Solutions for each building/chimney **must** be carefully considered on a case by case basis.

- Any reconstruction should be accurately replicate the visual appearance of the original chimney.



Photo: Heritage Replica Chimneys

Timber frame fabricated to original form with brick slips providing the skin.

- In order to ascertain the form of the original structure architectural plans (if available) should be studied. Photographs taken pre-damage will also provide valuable information.
- If sufficient information is not available to accurately replicate the original form rebuilding should not proceed. In such cases it may be deemed most appropriate to remove the chimney altogether. Use of conjecture is not considered acceptable on a heritage building.
- **Using original materials which have been modified.** Instead of replacing chimneys with bricks laid two or three deep, cut down bricks (brick slips) can be affixed to a suitable substrate to create a lightweight brick 'skin'. The substrate must be formed in such a way as to replicate the original structure of the chimney. The original bricks or matching bricks, carefully cleaned and prepared, should be used for the slips. Note – it is important to consider that this technique is new and issues such as longevity are yet to be proven.
- **Lightweight composite materials.** A number of companies are now manufacturing fibreglass replica chimneys. Fibreglass can potentially reduce the weight of a chimney from more than 1300kg down to approximately 60kg. This approach should be treated with caution. There is an enormous variation in the quality of replication provided by various companies. It is essential the colour matches the existing bricks, the form is accurate and the detailing is authentic as possible.



Photo: Reflex
Section of fibreglass replica chimney

Maintenance

Some of the damage chimneys suffered as a result of the Canterbury 7.1 magnitude quake could have been lessened had they been properly maintained. In many instances mortar had decayed and the shaking action caused the mortar to crumble and bricks to dislodge and fall. Deep re-pointing of the brickwork can increase the strength and flexibility of the structure.

Consultation

If your building is listed as a Heritage or Character building on the City or District Plan **or** it is registered with the New Zealand Historic Places Trust (NZHPT) you must consult with Council Planners and/or the Heritage Advisor of the NZHPT to comply with the requirements of the Resource Management Act 1991.

Is there funding to support owners of heritage buildings?

In response to the 4 September 2010 Canterbury earthquake the government, NZHPT and local authorities have established the Canterbury Earthquake Heritage Building Fund as a source of assistance for owners to repair damaged heritage buildings. Further information and advice can be obtained by contacting the NZHPT.

Heritage Specialists

A list of heritage specialists experienced in the repair and reconstruction of heritage buildings (including chimneys) is available on the NZHPT's website:

<http://www.historic.org.nz/en/ProtectingOurHeritage/FAQs-Earthquake.aspx>

Contact details are also available from the Christchurch City Council. Note - You will need to check with your insurer and EQC before proceeding with the employment of consultants or the carrying out of work.

Additional Sources of Information:

New Zealand Historic Places Trust – Sustainable Management Series – Information Sheets: <http://www.historic.org.nz/Publications/SustainMgtSeries.aspx>

Christchurch City Council Earthquake Damaged Buildings Guidelines for Building Owners:
Guideline 3 – Reconstruction of Elements
Guideline 4 – Strengthening of Buildings

Spiroloc Tubing (manufacturers of custom built, lightweight flue systems)
<http://www.spiroloc.co.nz/>

Reflex (manufacturers of custom built fibreglass chimneys)
<http://reflex.co.nz/industrial/architectural>

QSC [Quake Safe Chimneys] (manufacturers of custom built fibreglass chimneys
Ph. 0800-saferhomes [0800-723 374], info@quakesafechimneys.co.nz

Contact details are available from the NZHPT's website:

<http://www.historic.org.nz/ContactUs.aspx>

© Copyright, NZHPT,
December 2010