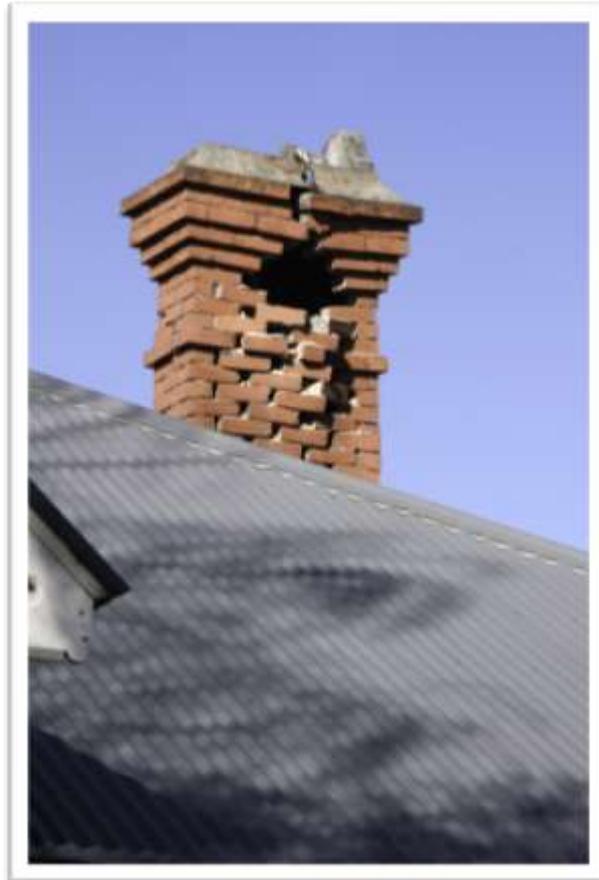


# **Quakesafe Building Solutions (NZ) Ltd**

## **Multi Criteria Evaluation**

**August 2013**



## Quality Assurance Statement

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## Revision Schedule

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# Quake Safe Chimneys

## Introduction

The purpose of this document is to simplistically and transparently outline the relative value of Quake Safe composite and brick veneer chimneys as a lighter, safer alternative to traditional brick and mortar type chimneys.

## Who should read this document

It is expected that the full spectrum of industry could benefit from awareness of this product, including:

- Local Council Post Earthquake Rebuild Teams (ECAN, CCC, SDC, WDC);
- Regulatory staff – consents and compliance
- Fletchers EQR
- Engineers / Designers/ Architects
- Department of Building and Housing
- Builders / Contractors (e.g. Master Builders Association, Contractors Federation)
- Insurance Industry
- Earthquake Commission
- Standards Committee
- IPENZ
- Historic Places Trust
- Architects Association (NZIA)

## Background

The 2010-2013 Canterbury earthquakes and subsequent aftershocks have resulted in terrible tragedy for wider New Zealand and in particular Canterbury. Extensive damage occurred to various infrastructure assets, including an estimated 85% of all traditional brick and mortar type chimneys. The recent 2013 Wellington/Marlborough earthquakes have also caused similar damage and anxiety.

### Traditional Chimneys:

Chimneys in New Zealand are traditionally of brick and mortar construction. These chimneys are heavy, weighing anywhere from 1300kg to 5000kg above the roofline. Older chimneys in New Zealand (1880's onward) were built using weak lime mortar. After the 1968 Inangahua earthquake in the S.I., many chimneys were repaired using stronger cement mortar. These repairs were often on top of the older and weaker lime mortar base/foundations. Newer chimneys (1970's onward) were built using the stronger cement technology. Examples of traditional chimneys – see **Fig. 1 below**.

### 'Traditional' Brick and Mortar Chimneys



### Earthquake Damaged Chimneys

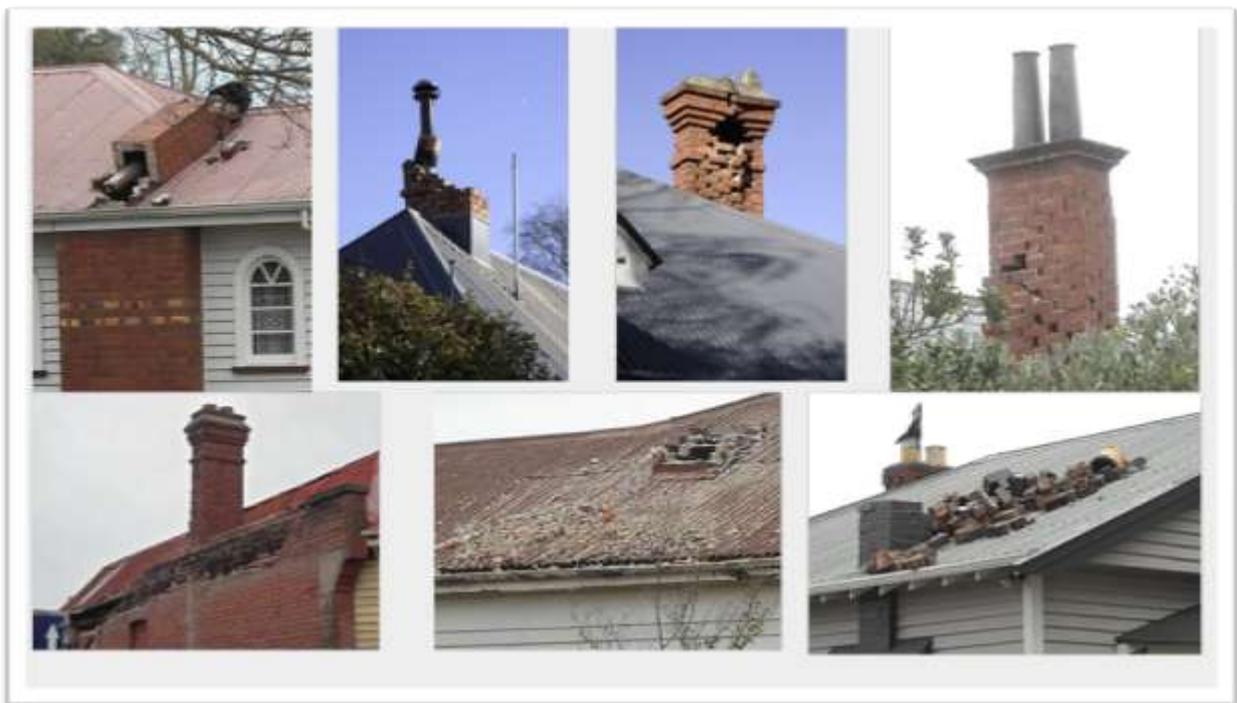


Fig. 1

## Earthquake Damaged Chimneys/Canterbury 2010-2013

There are numerous examples of traditional chimneys that have failed presenting significant safety risk (see **Fig. 2 below**). Many chimneys in Canterbury have been earthquake damaged beyond recovery and replacement will be required in most cases for reasons of functionality and/or aesthetic purpose. Older lime mortar chimneys fared poorly and the well meaning 1968 earthquake repairs (mentioned above) also failed, actually leading to more severe damage as entire Chimney tops fell off the older and weaker lime mortar bases causing extensive damage.



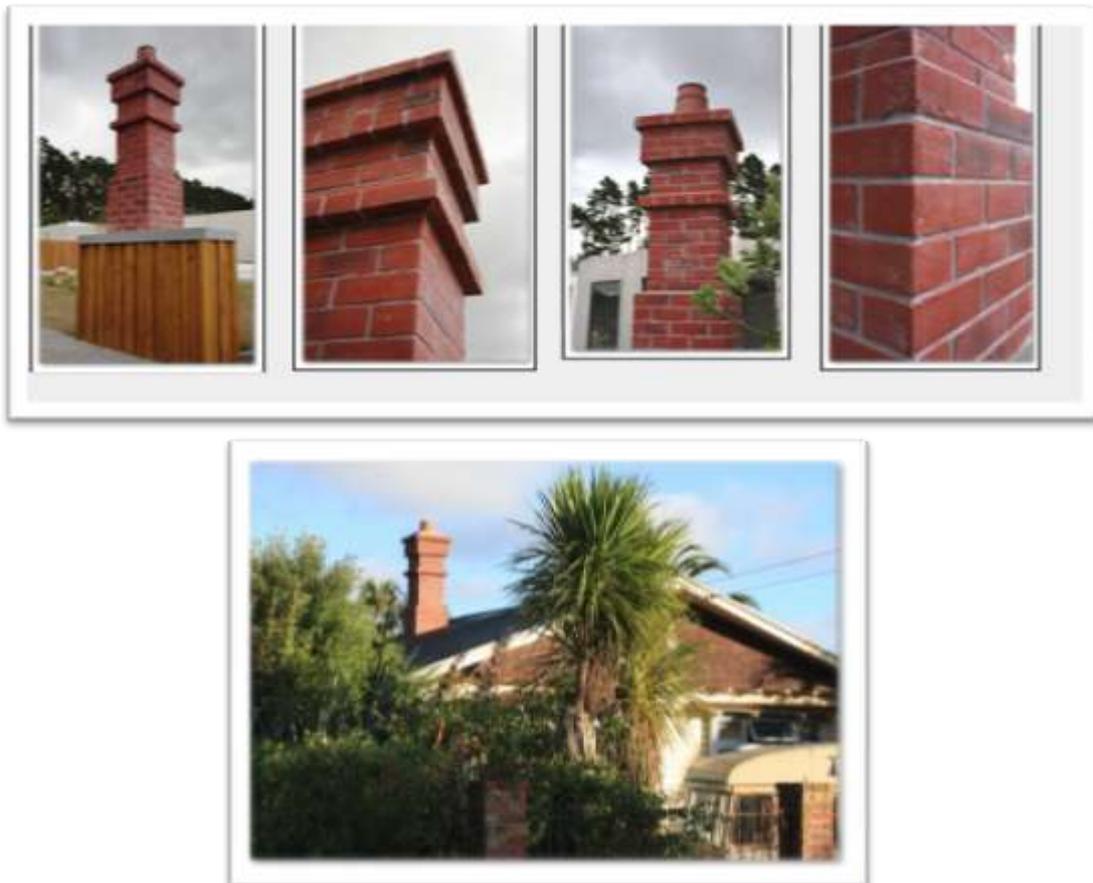
**Fig 2:** Extreme damage caused by Canterbury Earthquake 2010

## Quake Safe Chimneys

Quake Safe Chimneys has developed a range of alternative chimney solutions for replacement in the form of:

1. Textured, coloured and form finished fibreglass (full composite), that will as near as possible replicate the original chimney look and shape. These chimneys are super lightweight ranging from 35kg-70kg. - **See Fig. 3 below.**
2. Genuine brick slips (veneers) over form finished fibreglass to replicate the original chimney look and shape. These are lightweight ranging from 100kg to 300kg. **See Fig. 4 below.**

The Quake Safe Chimney patent applications provide for a light-weight, easy to install, functional, and safer alternative that aesthetically mimics an authentic brick and mortar chimney. The Chimneys are New Zealand made and provide a versatile capacity for installation. A robust concept and design has been developed for delivery of the Quake Safe Chimney, to ensure compliance with all relevant legal, engineering, and building requirements (standards, codes, practice, guidelines, etc). Building Code compliance considerations include weather tightness, structural standards (wind & earthquake), fire safety, and durability. This development should ensure confidence that functional outcomes required can be delivered by the Quake Safe Chimneys.



**Fig. 3:** The above example is of a Composite chimney fitted in Christchurch prior to the large 6.3 earthquake on 22/02/2011. This home in Redcliffs was very close to the epicentre and the general area sustained severe damage. The chimney and structure are undamaged.



**Fig. 4:** Examples of brick veneer Quake Safe chimney's fitted in Canterbury

## **Chimney Evaluation**

The issues, values and opportunities related to determining the most appropriate methods of chimney replacement can be generally best aligned by an evaluation of the key attribute (or value) criteria associated with customer and stakeholder driven outcome values, and reflect a good positive legacy, and whole of life value for money outcome.

For the purpose of a simplistic yet transparent assessment of the relative value of the Quake Safe Chimney versus the traditional chimney a value analysis evaluation (multi criteria evaluation) of key attributes has been undertaken on a qualitative basis. The evaluation includes prioritisation of the likely customer and stakeholder driven outcomes, followed by an assigned weighting of value. A score of one (1) to ten (10) has then been assigned to each of the attributes, with 10 being best outcome and 1 being the worst outcome. Where both the traditional chimney and Quake Safe Chimney deliver the same outcome then no score has been applied (neutral). Scores have then been tabulated with the highest scoring option generally preferred.

Twelve (12) primary outcome values have been identified, and the value analysis evaluation presented in **Table 1** below shows that Quake Safe Chimneys should holistically achieve the best value outcome.

**Table 1 – Multi Criteria Evaluation**

Attribute Criteria / Outcome Value	Priority	Weighting (%)	Quake Safe Chimney		Traditional Brick & Mortar	
			Score	Weighted Score	Score	Weighted Score
Health & Safety	1	20	10	2.0	5	1.0
Level of Service - Functionality	2	20	-	-	-	-
Amenity/Aesthetics	3=	10	8	0.8	10	1.0
Cultural Acceptability / Authenticity	3=	10	8	0.8	10	1.0
Durability / Resilience	5=	8	6	0.48	5	0.40
Cost to Install (supply, labour, plant)	5=	8	8	0.64	5	0.40
Maintenance Implications (cost/ease)	7	6	-	-	-	-
Disruption to residents	8	5	8	0.40	6	0.30
Failure to achieve outcomes desired (risk)	9	4	-	-	-	-
Construction - feasibility/achievability	10	3	6	0.18	5	0.15
Impact on Environment	11	3	-	-	-	-
Financial - Escalation (risk)	12	3	-	-	-	-
<b>TOTAL</b>		<b>100%</b>		<b>5.30</b>		<b>4.25</b>

## Evaluation Discussion

Based on the findings of the attribute value assessment shown in Table 1, it can be seen that Quake Safe Chimneys holistically deliver nearly 18% greater overall and relative value to that of traditional brick and mortar chimneys. A simplistic consideration of each of the attributes evaluated is as follows:

- 1. Health & Safety:** Health and Safety is considered a non-negotiable outcome. Quake Safe Chimneys Composite option weighs only about 5% of a traditional Chimney, meaning the risk of harm should failure occur is significantly reduced. The risk of failure is significantly reduced due to the light weight of the QSC.
- 2. Level of Service:** Functionality: Both forms of chimney will be functional hence a neutral score has been applied (albeit some chimney replacements may be solely for aesthetic purpose)
- 3. Amenity/Aesthetics:** Despite Quake Safe Chimneys near as possible replication of the original chimney (colour, texture and form), they will never quite be authentic, meaning the traditional chimney form outscores the Quake Safe Chimney on this account. When viewed typically at some distance (1 metre +) QSC's will be indiscernable from a genuine brick and mortar chimney
- 4. Cultural Acceptability / Authenticity:** Similar to amenity and aesthetics above, the Quake Safe Chimney is simply not completely authentic hence does not score as well as the traditional chimney form on this account
- 5. Durability / Resilience:** Neither form of Chimney has the highest level of durability and resilience. Traditional brick and mortar chimneys will always be susceptible to sudden failure caused by the lateral inertia loading resulting from an earthquake. Quake Safe Chimneys offers a 20 year full guarantee which is comparable to the design life for traditional chimneys. Due to the QSC option being significantly lighter and more robust in an earthquake event it has been scored higher.
- 6. Cost to Build and Install (supply, labour, plant):** It is clear that costs will be slightly less expensive for a Quake Safe Chimney than for a traditional chimney, due in part to increased engineering and consent costs for real chimneys. Savings in time and ease of installation will also result in a cheaper installed Quake Safe Chimney
- 7. Maintenance Implications (cost/ease):** It is anticipated that the implications of nature and frequency of operational maintenance will be similar (neutral)
- 8. Disruption to residents:** It is expected that using the Quake Safe Chimney the time for installation will be significantly less, as well as requiring less product, and fewer people involved with the installation, and hence less general disruption to residents.
- 9. Failure to achieve outcomes desired:** It is anticipated that both the Quake Safe Chimney and the traditional chimney will deliver customer driven outcomes

**10. Construction – feasibility/achievability:** Both the Quake Safe Chimney and traditional chimney will be constructible and generally have sufficient versatility and flexibility to accommodate the range of installation situations that will be encountered. Owing to practical limitations associated with the range of chimney and roof construction configurations the QSC Solutions will be limited by the number of chimney moulds initially produced. This will be offset somewhat by design modularity and bespoke /custom options. Traditional chimney construction will be limited at times by poor weather and the lack of skilled traditional chimney builders available.

**11. Impact on Environment:** The environmental impacts (aesthetic, noise, contaminants, etc) associated with Quake Safe Chimneys and Traditional chimneys will be similar (neutral). Both solutions are relatively inert and innocuous.

**12. Financial – Escalation:** The risk of financial escalation associated with the installation (supply, labour, plant) of both forms of chimney are considered to be of similar likelihood and consequence, hence are considered to be neutral.

## **Conclusions**

- The Canterbury Earthquake caused extensive building stock and infrastructure damage, including tens of thousands of chimneys.
- Traditional brick and mortar chimneys present a significant safety risk in the event of failure as a result of falling debris in the event of an earthquake.
- Quake Safe Chimneys (colour, texture and form finished fibreglass or brick veneers) are a good light weight and safer alternative solution for the replacement of original chimneys.
- Multi criteria (attribute) evaluation has transparently demonstrated the holistic merits of the Quake Safe Chimney solution as a good viable alternative to the traditional masonry chimney.