

## Globally relevant

**The Ground Improvement Programme is a significant step forward in understanding the effects of liquefaction damage and ways to reduce damage in future earthquakes.**

While the Ground Improvement Programme was driven by the needs of the Canterbury community following the 2010-2011 earthquakes, the lessons learned are applicable globally.

**Anywhere there is a building on land vulnerable to liquefaction, ground improvement work can improve the likely outcome after an earthquake.**

The shallow ground improvement methods can be undertaken prior to building, and give houses increased resilience to future earthquakes.

Many of the insights gained are also applicable and can be adapted to areas with commercial land and building developments.



*Reinforced Gravel Raft – geogrid and gravel installation*

## Ground improvement in action

Using preliminary findings from the Ground Improvement Programme, the Ministry of Business, Innovation and Employment has updated its 2015 guidelines for repairing and rebuilding houses affected by the Canterbury earthquakes.

**The Ministry of Business, Innovation and Employment guidance (2015) is available at:**  
[www.mbie.govt.nz](http://www.mbie.govt.nz)

**To find out more about the Ground Improvement Programme:**  
[www.eqc.govt.nz](http://www.eqc.govt.nz)



**EQC**  
EARTHQUAKE COMMISSION  
Kōmihana Ruwhenua

# The Ground Improvement Programme

The 2010-2011 Canterbury Earthquake Sequence consisted of four main earthquakes and more than 10,000 aftershocks. These earthquakes triggered widespread liquefaction and land damage throughout the region.



## About the Ground Improvement Programme

The scale of land damage as a result of the 2010-2011 Canterbury Earthquake Sequence is unlike that experienced by any other community in New Zealand. Some land can't be used, changing lives and the face of Christchurch.

The Ground Improvement Programme is a world-first research project led by the Earthquake Commission (EQC), aimed at identifying affordable and practical solutions to improve or strengthen residential land that is vulnerable to liquefaction.

The Ground Improvement Programme brought together New Zealand and international organisations in a significant collaboration to investigate earthquake-related liquefaction.

The team developed practical, cost-effective ground improvement methods to increase the resilience of land to reduce future earthquake damage.

By strengthening residential land more people will be able to remain in communities built on land vulnerable to the damaging effects of liquefaction.

**Liquefaction – where soil temporarily loses strength causing it to behave like a liquid in response to earthquake shaking.**

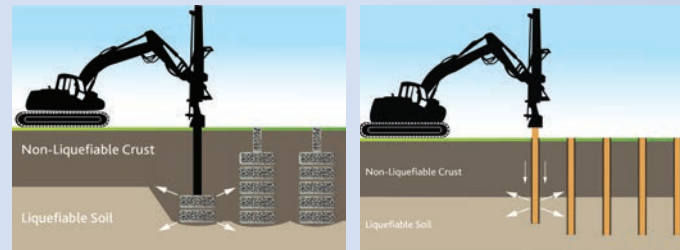


## Ground improvement methods

**The Ground Improvement Programme has identified four practical methods to strengthen residential land vulnerable to liquefaction on cleared sites, and one method to strengthen land where a home is still in place.**

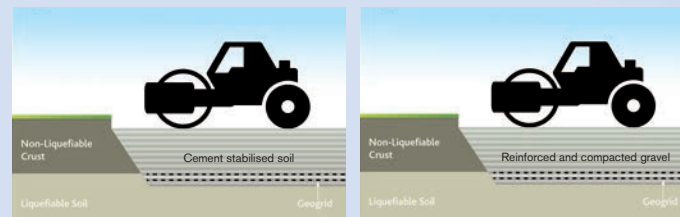
Ground improvement techniques reduce liquefaction vulnerability by:

- Thickening the non-liquefying soil crust, or
- Strengthening and/or stiffening the soil crust.



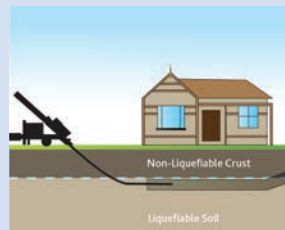
Stone Columns

Driven Timber Poles



Soil-cement rafts

Reinforced gravel rafts



Horizontal Soil Mixed Beams

## The Ground Improvement Programme provides:

- Practical and affordable solutions to increase the resilience of residential land vulnerable to liquefaction.
- Methods of ground improvement suitable to a wide range of soil types, building lot sizes and water table depths.
- Real-world solutions developed using a realistic testing and pilot programme.
- Streamlined consenting for residential ground improvements, reducing costs and administration.
- Increase in contractor capacity and capability, with refinements to construction methods to ensure consistent results and improved health and safety procedures.
- Updated Ministry of Business, Innovation and Employment (MBIE) guidelines for building on land vulnerable to liquefaction in Canterbury.
- Insights which can be adapted for use in commercial buildings.



Construction of driven timber poles