



# What were the Canterbury Ground Improvement Science Trials?

The Canterbury Ground Improvement Science Trials (the Science Trials) involved the construction and testing of shallow ground improvement methods considered suitable for reducing the liquefaction vulnerability of residential properties. The Science Trials were carried out between April and December 2013 in the Christchurch residential red zone. The work was largely funded by the Earthquake Commission (EQC) and coordinated by Tonkin + Taylor (T+T).

## Why were the Science Trials carried out and what were the objectives?

The Science Trials were undertaken to:

1. Develop robust and affordable ground improvement options, which could be constructed on residential properties for varying soil conditions to reduce liquefaction vulnerability
2. Test the effectiveness of each of the ground improvement methods in improving the performance of liquefaction-vulnerable land.

## What ground improvement methods were tested?

The following ground improvement methods were identified as options for cleared sites and tested:

- Rapid impact compaction

- Rammed Aggregate Piers
- Low mobility grout
- Driven timber poles
- Reinforced gravel rafts
- Reinforced soil-cement rafts
- Resin injection.

In addition, the following methods were trialed at properties under existing repairable houses:

- Permeating grouting
- Horizontal Soil Mixed beams – a new, innovative method for strengthening land vulnerable to liquefaction underneath existing houses.

## How was the ground improvement tested/measured?

Each method was extensively tested and assessed using a variety of methods, including:

- Cone penetration testing
- Crosshole geophysical testing
- T-Rex shake testing (truck-mounted vibrating)
- Blast-induced liquefaction testing
- Excavation and observations.



Preparation for blast induced liquefaction testing



T-Rex – machine for liquefaction triggering testing

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**What have been the benefits from the Science Trials?**

Results from the Science Trials have advanced understanding of the performance of shallow ground improvement for scientists and engineers all around the world.

These effective shallow ground improvement methods are more affordable than deeper methods, giving property owners more ground improvement and foundation options than previously economically viable.

The results have also helped Ministry of Business, Innovation and Employment (MBIE) in updating the 2015 its guidance: *Repairing and rebuilding houses affected by the Canterbury earthquakes*, Section 15.3 update, Version 3a. This guidance adopted some of the shallow ground improvement methods included in the Science Trials.



Installing steel casings for construction of low mobility grout ground improvement



Construction of Rammed Aggregate Piers



Rapid impact compaction equipment



Construction of reinforced gravel raft test panel