Case Study

Liquefaction Mitigation

Christchurch, NZ

Market Sector

RESIDENTIAL

Application

LIQUEFACTION MITIGATION

Site Conditions

SANDS

LANDPAC
INTELLIGENT GROUND ENGINEERING SOLUTIONS

Project

Prestons is a dynamic new residential 203ha subdivision located north east of Christchurch which has been designed to be a sustainable urban village which includes plans for 2500 Homes, commercial sectors, shopping, leisure and educational facilities.

Large areas on site were designated as being susceptible to liquefaction under earthquake conditions. These areas were categorised on site as TC2 denoting its liquefaction deformation limits.

Landpac was engaged as the ground improvement contractor using High Energy Impact Compaction (HEIC) to improve the ground to TC1 by the in-situ densification of the upper soil in-situ Sand stratum and reduce the liquefaction potential at the site.

Some areas were designated as being more susceptible to liquefaction than others and received a higher level of ground improvement during HEIC works (more surface passes using HEIC).

Client: Ngai Tahu

Consultant: Aurecon

Ground Improvement Contractor: Landpac Ground Engieneering

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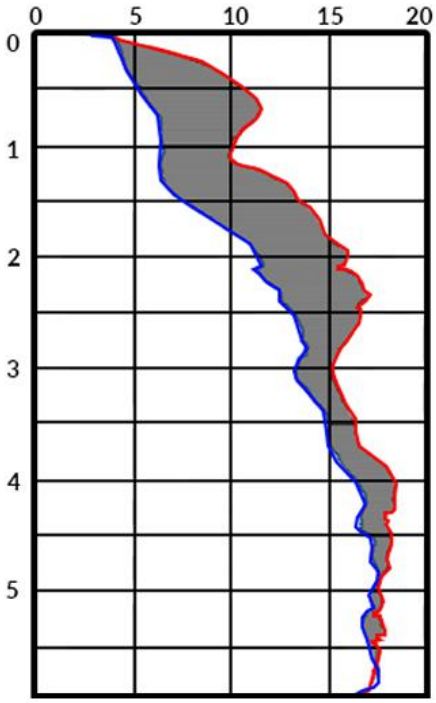
Soil Conditions

Based on geotechnical investigations encountered the potentially liquefiable sand stratum appeared predominantly within the upper 3m of the soil profile with water levels varying from 0.5m-2m below OGL with further liquefiable layers at depths greater than 8m. For the ULS earthquake events (assumed worse case scenarios) the thickness of the liquefiable layers in the upper 3m ranged up to 1.5m but typically 0.6m thickness or less. Due to the liquefaction predominantly considered to be within the upper 3m there was also risk of lateral spreading adjacent the retention ponds and drains channels. Ground conditions were predominantly fine to medium grained beach sands with high RL areas (dune remnants) comprising of fine to medium grained dune sands. Thin organic layers (<200mm) were present in localized areas throughout the site.

Average Improvement



Depth (m)	Qt (Mpa) Increase
1 - 2m	5.19
2 - 3m	3.38
3 - 4m	1.70
4 - 5m	1.07
5 - 6m	0.37

Note: Average of 30 CPT's

Designed to be a sustainable urban village

Geotechnical Solution

Based on the geotechnical consultants analysis there were 2 main areas requiring ground improvement. The first was ground improvement of the residential lots from TC2-TC1 and the second was to mitigate potential risk of lateral spreading adjacent the ponds and drains. As part of the geotechnical design full scale trials were conducted to determine the appropriate ground improvement method. Impact compaction was used as the primary ground improvement methodology directly onto the topsoil surface.

By densifying the upper 3m the near surface liquefaction potential and liquefaction settlements are reduced, which would form a thick non-liquefiable crust in the order of 7m to 8m thick, once the deeper non-liquefiable sandy soils to 7m-8m are included. Liquefaction analysis by Aurecon indicated that the upper 3m was sufficiently densified to suppress liquefaction susceptibility. Liquefaction induced free field settlements in the upper 3m were reduced in the order of 40% - 90%, depending on soil type.

Monitoring & Verification / QA

The ground improvement works were monitored with Landpac's Intelligent Compaction Measurment (ICM) soil response system during the Impact Compaction process. The ICM identified soft or deleterious sub-grades which were then removed and replaced with appropriate compactable material. The soil design parameters post IC works were verified using CPT's (Cone Penetrometer Testing).

The analysis of the testing confirmed that the ground improvement process had satisfied the post construction settlements and were within the required TC1 liquefaction deformation limits should seismic activity occur. HEIC has allowed the subdivision to be classified as MBIE TC1 equivalent.

Summary

- Elimination of an imported pavement layer
- Superior subgrade strength
- Construction time & cost savings
- Classified as MBIE TC1 equivalent

Get in touch

1300 237 045

info@landpac.com.au

www.landpac.com.au

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