DYNAMIC CHARACTERISATION OF CENTRAL AUCKLAND RECLAIMATION ZONES

Kuanjin Lee and Liam Wotherspoon

THE UNIVERSITY OF AUCKLAND
Te Whare Wānanga o Tāmaki Makaurau
NEW ZEALAND

QuakeCoRE
NZ Centre for Earthquake Resilience

OBJECTIVES

The aim of this project was to define the dynamic characteristics of the reclaimed land in the Auckland CBD using a combination of geotechnical, geological and geophysical data. The objectives were:

1. Understand the history of reclamation and sub-surface geology from historical ground investigations to provide constraints for the surface wave testing.
2. Define the shear wave velocity of the deposits in the reclamation zones.
3. Define a range of site classification metrics across the region.

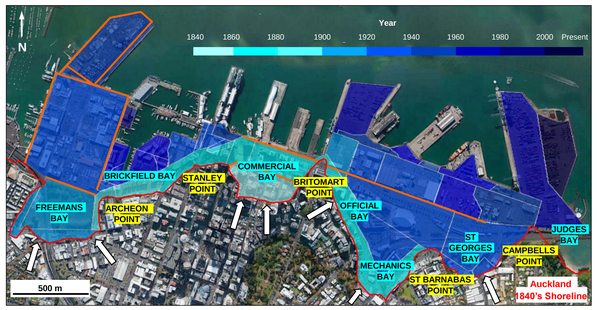

Figure 1. Auckland CBD zones of reclamation, darkening towards present day. Historic sea walls (orange) and Auckland's original 1840's shoreline (red), bays (light blue), headlands (yellow), paleo-river/stream channels (white arrows showing direction of flow).

RECLAMATION HISTORY

Reclamations began in bays closest to the shoreline using local ECBF material from nearby headlands (Fig. 1). Examples of this include Commercial Bay, Brickfield Bay, Official Bay and Mechanics Bay, that all used material excavated from Stanley Point and Britomart Point.

From the early 1900's, having depleted local sources, there was a shift to use hydraulic fill sourced from the Waitemata Harbour. Examples of this include Wynyard Quarter and areas of Britomart Transport Centre.

In the late 1980's and early 2000's, mudcrete was used to extend reclamations in the Viaduct Harbour and eastern areas of Wynyard Quarter.

Across the reclaimed zones these fills overlie Tauranga Group Alluvium (TGA) which thickens in paleo-channels above the East Coast Bays Formation (ECBF) sandstone and mudstone deposits.

METHODS

- Site investigation data and geomorphic characteristics were used to develop representative soil profiles in each reclamation zone and develop surfaces for the top of the ECBF and the base of the reclaimed deposits. Historical subsurface data across the region from a number of sources was used in this process.
- Over 100 horizontal-to-vertical spectral ratio (HVSR) measurements were made to provide a estimate of the site period of the reclaimed soil profiles, and identify contrasts between adjacent reclaimed zones.
- At a reduced number of sites, surface wave testing was performed to provide an estimate of the shear wave velocity of the deposits. The profiles developed in this process were constrained using knowledge of subsurface stratigraphy.

RESULTS

1. COLLATED SUBSURFACE INVESTIGATIONS

Subsurface investigations revealed that the soils varied greatly across and within each of the reclamation zones. Sites proximal to the 1840's shoreline generally contain shallow (0 – 4 m) fill and Tauranga Group deposits. However, collated subsurface investigation data and geomorphic cues show that there are ECBF incised paleo-channels up to approximately 20 m depth across the reclaimed zones, as shown by the blue regions in Fig. 2. In areas such as Britomart (previously known as Commercial Bay), the stratigraphy is highly layered and has sharp changes in both composition and stiffness relative to depth.

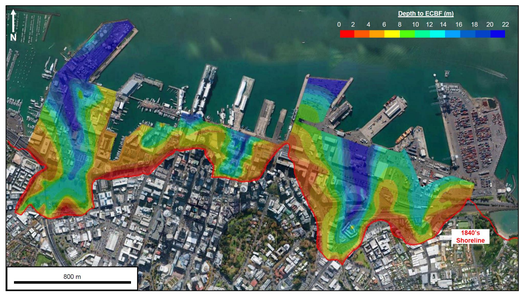

Figure 2. Surface representing depth to unweathered East Coast Bays Formation beneath Auckland zones of reclamation based on subsurface site investigation data. Zones without contours did not have enough investigation data to develop surfaces.

2. SITE PERIOD ESTIMATES

HVSR and shear wave velocity profile derived site period estimates above the unweathered ECBF are summarised in Fig. 4. In general, the longest periods were identified in areas which were furthest offshore from the 1840's shoreline and within paleo-channels identified in Fig. 2. Examples of spectral ratio peaks from HVSR data are summarised below.

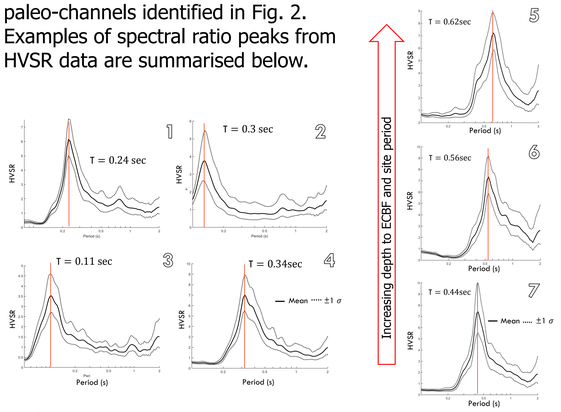

Figure 3. Examples of HVSR data and spectral peaks corresponding to response of soil profile above the ECBF rock. Location of these measurements summarised in Fig. 4 below, with outlined data from Wynyard Quarter.

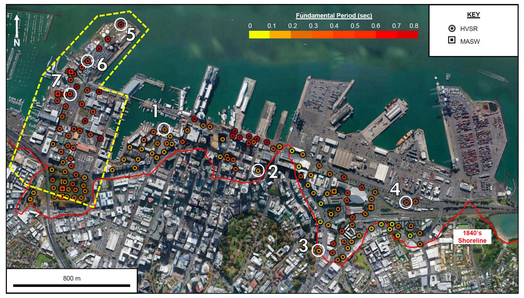

Figure 4. Summary of site period above East Coast Bays Formation based on HVSR and shear wave velocity measurements. Yellow outlined area is the case study data in Fig. 3 in Wynyard Quarter (reclaimed 1905 -1931).

3. SHEAR WAVE VELOCITY PROFILES

Surface wave testing showed that the upper TGA deposits had lower shear wave velocities than most of the reclaimed materials, and only slightly higher than the hydraulic fill. Fig. 5 summarises the velocities of different materials.

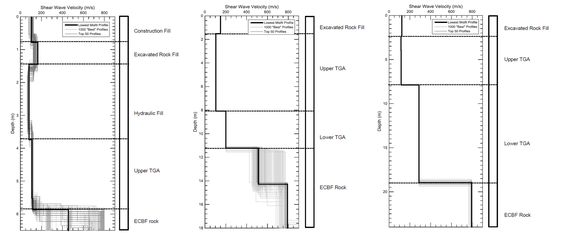

Figure 5. Examples of shear wave velocity profiles from surface wave testing at a range of locations across the reclaimed region. The middle figure shows a weathered ECBF layer above the unweathered deposits.

4. SITE SUBSOIL CLASS

The majority of the reclaimed region was site subsoil class C, with site subsoil class D sites located proximal to paleo-channels in the area containing thickened deposits of alluvial material and in reclaimed areas that extended further out into the harbour.

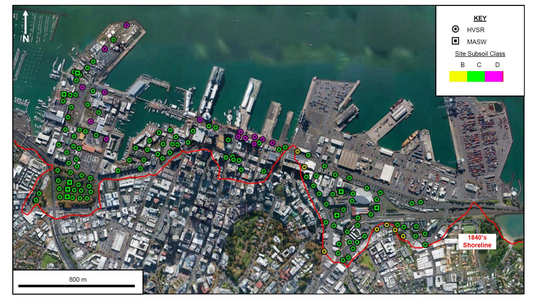

Figure 6. Summary of NZS1170.5 site subsoil class across Auckland zones of reclamation. This focusses on site period based classification, and more detailed investigations may reveal that site subsoil class E is appropriate, especially in the paleo-channel regions.

In general, the site periods correspond well to the depth to bedrock contours, as site period increases with increasing depth to bedrock (Fig. 7). Additionally, there is no clear differences in the relationship between site period and depth across the different reclaimed zones using different reclamation materials.

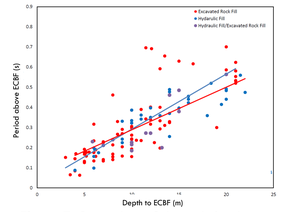

Figure 7. Comparison of site period estimate from HVSR testing and depth to ECBF deposits. There is a clear trend of increasing site period with depth to ECBF, but no clear difference in this trend for different reclamation materials.

CONCLUSIONS

Across the highly variable reclaimed deposits in central Auckland subsoil class C was the most prevalent based on site period, with site subsoil class D sites located proximal to paleo-channels and in reclaimed areas that extended further out into the harbour. More detailed investigations are needed to identify potential site subsoil class E sites and areas susceptible to liquefaction.

Comparisons across all reclaimed zones suggested that the underlying young, unconsolidated Tauranga Group alluvial deposits had more influence on the site period than the various reclaimed deposits.

The HVSR method was shown to be a valuable technique for providing a rapid assessment of the depth to the ECBF deposits in the region.

ACKNOWLEDGEMENTS

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