Tonkin & Taylor

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Arthouse Architecture Ltd
PO Box 1325
Nelson 7040

Attention: Brian Riley

Dear Brian

Structural capacity of existing piles supporting the Trafalgar Centre, Nelson

Introduction

In accordance with your request (email dated 11/03/2014), and in accordance with the terms and conditions outlined in our original Letter of Engagement, dated 06 March 2013, Tonkin & Taylor Ltd (T&T) have carried out additional work on the Trafalgar Centre, Nelson.

The scope of work carried out includes:

- Calculation of the design structural capacity of the existing reinforced concrete piles supporting the Main Hall and Northern Extension, for bending, shear, structural compression and tension;
- Comparison of the structural capacity of the piles to the seismic inertial load demands acting on them from the building. Load demands have previously been supplied to us by Holmes Consulting Group Ltd (HCG).

This letter does not pertain to the geotechnical capacity of the piles, or the additional loading applied to the piles due to ground motion during an earthquake. If required, a following stage of work will consider this.

Methodology

The structural capacity of the existing piles was calculated based on the concrete and reinforcement details described on the original drawing by Sanders and Lane Consulting Engineers, drawing sheet S28, 'Revised Pile Plan (Bulb Piles) and Pile Cap Details'. Calculation methods utilised were in accordance with the requirements of the current New Zealand Concrete Structures Standard, NZS 3101: Part 1: 2006.

The yield strength of the steel reinforcing was estimated based on the New Zealand Bridge Manual of the time when the piles were constructed.

The structural capacities of the circular cross section of the pile are relatively simple to determine, and are independent of the pile length.

Comparison of capacity and demand

We have made the following comparisons of load demand vs capacity:

- Main Hall, eastern arch support piles: the shear load demand placed upon the piles in an IL3 Ultimate Limit State (ULS) earthquake will exceed the shear capacity of the piles, leading to shear failure.
- Northern extension internal piles: the shear load demand placed upon some of the central piles in an IL3 ULS earthquake will exceed the shear capacity of these piles. These piles would fail in shear. This may lead to loads being redistributed to adjacent piles causing failure of adjacent piles as well.
- Northern extension piles: the shear load demand placed upon some of the central piles in an IL3 ULS earthquake will not exceed the shear capacity of these piles, unless significant load redistribution from the failed central piles occurs.

Please note that the structural shear capacity of the piles is not affected by whether the piles are 4 m or 10 m long.

Other considerations

Concrete cover

The capacity calculations make no attempt to quantify any corrosion of the steel reinforcement that may have occurred. Drawing sheet S28 is dated May 1971, so the piles are likely to be over 40 years old. The groundwater in the area is likely to be salty (the Maitai River and Saltwater creek are influenced by sea water). The Concrete Structures Standard does not give a specific value of the minimum concrete cover to the reinforcement for the strength of concrete shown on the drawings, but it can be inferred that the minimum required cover for a 50 year design life is more than 45 mm. No records of the as-built concrete cover are available to us, and the actual cover is likely to vary from pile to pile. It should be noted that corrosion of the reinforcement is likely to have occurred in some of the piles. This would reduce the structural capacity of the piles from that calculated. Therefore, the calculations represent an optimistic estimate.

Additional loads applied due to ground motions

The loads applied to the piles by the ground motion in an earthquake are more difficult to estimate than those applied by the building. Due to the tight timeframe of this work, it is quicker to initially consider only the loads applied to the piles by the structure. If the piles fail due to these loads, the question of what loads are applied to the piles by the ground becomes irrelevant.

Conclusions

Based on the work carried out, we conclude the following:

- Piles supporting the eastern side of the Main Hall arch beams will likely fail in shear in an IL3 ULS earthquake.

- Piles within the Northern Extension interior will likely fail in shear in an IL3 ULS earthquake.
- Piles under the exterior walls of the Northern extension may have sufficient capacity to resist shear loads imposed by an IL3 ULS earthquake, though this depends on the amount of load redistribution that occurs after failure of the internal piles.
- Corrosion is likely to have occurred in some of the piles. This would reduce their structural capacity, and hence the comparisons are optimistic.

Applicability

This report has been prepared for the benefit of Arthouse Architecture Ltd with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose without our prior review and agreement.

Tonkin & Taylor Ltd

Environmental and Engineering Consultants

Report prepared by:	Reviewed and Authorised for Tonkin & Taylor Ltd by:
Daniel Andrews	Mark Foley
Geotechnical Engineer	Project Director

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