



TONKIN & TAYLOR LTD. ENVIRONMENTAL & ENGINEERING CONSULTANTS

19 MORGAN STREET NEWMARKET AUCKLAND NEW ZEALAND

PO BOX 5271 WELLESLEY STREET AUCKLAND 1036 NEW ZEALAND

PH 64-9-355 6000 FAX 64-9-307 0265

Our Ref: 15549
19 September 1997

BSK Consulting Engineers Ltd
P O Box 23
ROTORUA

RECEIVED	
PLANS APPROVED SUBJECT TO ALL REQUIREMENTS OF THE BUILDING ACT 1991 BEING FULLY COMPLIED WITH	
Date _____	Consent Number _____
Officer _____	

Attention: Mr John Kronast

Dear Sir

PROPOSED COMMERCIAL DEVELOPMENT PUKUATUA STREET, ROTORUA

In accordance with your request of 15 August regarding the review of the "subexcavation / replacement" option for the above project, we confirm completion of the study and this correspondence summarises our findings.

The use of shallow footings is an acceptable alternative for the site development subject to allowing for subexcavation of the upper soft subsoils and backfilling with a lightweight fill. There is a low risk of settlement under a design seismic event due to possible liquefaction of underlying loose sand lenses. Construction of the foundation and pavement works will need to be carefully planned to avoid remoulding of the weak soils.

1.0 BACKGROUND AND OBJECTIVES

The subject site, situated at the corner of Pukuatua Street and Ranolf Street, Rotorua, was the subject of a previous investigation carried out by our company in 1992 (ref 1). The results of this work show the site subsurface conditions are dominated by the presence of soft silts characterised by low shear strength and high compressibility. Below these weak materials, medium dense to dense sands were encountered at approximately 4 m depth in the eastern part of the site and 12 m in the western part. The measured groundwater levels ranged from 0.9 to 1.2 m depth below existing ground level.

We understand the proposed development concepts provide for either one or two storey timber frame lightweight buildings with cast in-situ concrete ground floors. Design (Dead plus Live) loads advised by BSK range from 12 kN/m for the perimeter walls to 21.5 kN/m for the internal walls. The objective of this requested geotechnical review has been to assess the concept of "subexcavation and replacement" of a sufficient thickness of the upper materials beneath the footings in order to provide acceptable founding conditions. Our previous foundation concepts were for pile foundations, taken down to the underlying medium dense sands.

2.0 SCOPE OF REVIEW

The scope of the review which has been carried out has comprised an assessment of appropriate foundation design parameters, estimates of likely settlements and issues to be considered for foundation construction. The review has been based upon the results of our geotechnical investigation and the structural loading information provided by BSK. We have also assessed pavement design concepts assuming concrete pavers would be used and details are presented below.

3.0 GEOTECHNICAL ENGINEERING

3.1 Introduction

Recommendations and opinions in this report are based on data from field tests previously carried out. The nature and continuity of the subsoils away from the test locations is inferred but it must be appreciated that the actual conditions could vary from the assumed model.

3.2 Shallow Foundations

On the basis of the field test results and providing for subexcavation to "2 x B" (B = footing width) below founding level, we consider an ultimate bearing capacity of 150 kPa can be assumed for design purposes. For the advised structural loads, the required footing widths are 0.40 m (perimeter) and 0.45 m (internal). The sub-excavation would need to extend "2 x B" beyond the side of the footing to allow for load spreading. Recommendations for backfilling are presented in section 3.6.

We have checked the likely settlement of the foundations based upon assessed consolidation parameters of $m_v = 3 \times 10^{-3} \text{ m}^2/\text{kN}$ for the upper silts, and $m_v = 2 \times 10^{-4} \text{ m}^2/\text{kN}$ for the compacted fill. This latter value is a lower bound for granular fill, taken to reflect the likely low standard of compaction which may be achieved due to the soft subgrade. The estimated settlements are 10 to 15 mm for the perimeter footing and 15 to 20 mm for the internal footing.

3.3 Ground Floor Slab

We understand that there will be minor filling ($\approx 0.2 \text{ m}$) carried out for the ground floor slab construction. Whilst only 0.2 m thickness may be required above existing ground level, we consider a thickness of not less than 0.3 m should be provided by way of subexcavation to improve the "raft" effects of this layer. Provision should be made for a geotextile over the subgrade and a geogrid reinforcement layer (i.e. Tensar 5520) would further improve the stiffness of the fill.

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3.4 Seismic Risk

We have previously commented on the likely risk of liquefaction of the loose sand layers which are inferred to underlie the site. The results of the investigation appear to show that the sands are generally discontinuous lense formations. These materials are also of limited thickness which we consider unlikely to present a risk of severe damage due to liquefaction - under a design seismic event. Some minor isolated settlement may occur which should be relatively minor, provided the provisions for "stiffening" the backfill material are incorporated.

3.5 Pavement Construction and Design

The construction of the pavement for the site access would need to be carefully carried out given the soft subgrade conditions. It will be critical to avoid remoulding the insitu materials given their sensitive characteristics. The works will need to be progressively constructed, ensuring an adequate thickness of compacted pavement material beneath the construction plant.

We have prepared a preliminary design for the concrete block pavement based upon published charts and assuming a CBR of less than 3%. Vehicle loadings should be confirmed prior to detailed design. The concept design details are as follows:

Option 1:

- 80 mm ICB paving
- 20 mm Sand blinding
- 150 mm 3% cement stabilised M4 basecourse

Option 2:

- 80 mm ICB paving
- 20 mm Sand blinding
- 100 mm M4 basecourse
- 100 mm sub-basecourse
- 1 layer Tensar SS30 geogrid
- 50 mm sand
- 1 layer of filter cloth (eg Terram 1000S)

3.6 Construction Issues

For the subexcavation and backfilling works associated with the foundation construction it will be essential to consider the following issues:

i) Groundwater level

The measured groundwater level was relatively shallow and it will be necessary to make

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provision for dewatering during construction. From our experience we would anticipate a relatively high level of contamination and Regional Council are expected to require discharge to a disposal pit on site..

ii) **Fill Material and Compaction**

The completed excavation would need to be lined with a suitable geotextile prior to backfilling. In addition, the geogrid layer beneath the floor slab should drop down and extend into the fill beneath the footing. The backfill material should comprise a suitable lightweight material such as a (quarry) pumice placed in the layers of say 100 to 200 mm loose thickness and lightly compacted with a roller. A detailed specification can be provided for construction.

4.0 CONCLUSIONS AND RECOMMENDATIONS

On the basis of the results of our previous investigation and the review presented in this report, we summarise our conclusions and recommendations as follows:

- i) Shallow footings would be appropriate for the lightweight development, subject to the provisions for subexcavation and backfill using compacted pumice fill.
- ii) A 0.3 m thick layer of pumice fill should be used beneath the ground floor slab.
- iii) The use of a suitable geotextile over the excavation subgrade and incorporation of a layer of geogrid within the fill would be appropriate beneath the building and foundations.
- iv) The construction works will need to be carefully planned in order to avoid remoulding and disturbance of the sensitive weak subsoils.
- v) Provision for dewatering of the foundations during construction will need to be considered and appropriate consents obtained for the on-site disposal of groundwater which is likely to be contaminated.
- vi) A concept pavement design comprising a thick layer of granular material would be appropriate for the carpark/access area. A detailed design should be carried out once actual vehicle loadings are available.

5.0 APPLICABILITY

This report has been prepared for the particular brief given to us and data or opinions contained in it may not be used in other contexts or for any other purpose without our prior review and agreement.

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During excavation and construction, the site should be examined by an engineer competent to judge whether the exposed subsoils are compatible with the inferred conditions on which the report has been based. We would be pleased to provide this service to you and believe your project would benefit from the continuity. However, it is important that we be contacted if there is any variation in subsoil conditions from those described in the report.

Yours faithfully
TONKIN & TAYLOR LTD



C J Freer
SENIOR GEOTECHNICAL ENGINEER

CJF:MCS
JA1554/9CJF1909.LTR
19 September 1997

25-Feb-00

Palms Unit Title Development at 96 - 100 Pukuatua Street

Legal	Address	File	Assessment	Owner	Caution/Hazard
Lot 2 DPS 82612	96 Pukuatua	P 00858	06500/729.00	Gadsby	Inundation Building Restriction Reserves contribution
Lot 1 DPS 82612	100 Pukuatua Body Corporate	P 00859	06500/731.00	Body Corporate	Fill Inundation Geothermal Building Restriction Other matters ?(refer letter from N Hill 26 March 1999)
PU 1 DPS 82877	F1/100 Pukuatua	P 29871	06500/731.00A	Dohnt	?
PU 2 DPS 82877	F2/100	P 29786	06500/731.00B	Archibald	?
PU 3 DPS 82877	F3/100	P 29872	06500/731.00C	Marshall	?
PU 4 DPS 82877	F4/100	P 29873	06500/731.00D	Maclean	?
PU 5 DPS 82877	F5/100	P 29787	06500/731.00AA	Bosstan	?
PU 6 DPS 82877	F6/100	P 29788	06500/731.00AA	Bosstan	?