GEOTECH
consulting ltd

4402
5 June 2012

Alan Reay Consultants Ltd
PO Box 3911
Christchurch

Attention: Alan Reay

Dear Sir,

RE: CTV Building – 249 Madras St

You have asked for comment on some aspects of the foundations and subsurface effects at this site. I was the engineer responsible for managing and writing the 1986 geotechnical report from Soils and Foundations, with internal peer review by Mr Don Preston. I do not have the original files to refer to, but you have forwarded a copy of the 1986 report..

1 Modulus of Subgrade Reaction

(a) Values recommended in 1986

You have asked what values I would have used at the time of the CTV building design in 1986.

The modulus of subgrade reaction is defined as ks = q/y where q is applied stress and y = deflection. At the time of the design, I would have been considering the normal gravity loading case, and the simplest way to estimate it is therefore straight off the settlement – bearing pressure curves. Using Figure 299/3 from the 1986 report, I get the ks values for a square pad as shown in columns 6 &7 of Table 1. As a check I have also rerun a settlement estimate independently of the original calculations and model, and obtained the values in the previous four columns, 2 - 5. There is good agreement (in geotechnical terms!!)

1	2	3	4	5	6	7	8
Footing Width (m)	From 2012 estimate				From 1986 report		From plate bearing test Lichfield St 1984
	Gravel Square	Strip	NE Square	Strip	Gravel Square	NE Square	
0.5	20.8	10.8	19.6	8.8			
1	10.6	6.5	9.4	5.0	10.6	10.4	3.4
1.5	7.4	5.0	6.2	3.7			
2	5.9	4.2	4.7	3.0	6.4	4	2.6
2.5	5.0	3.8	3.9	2.6			
3	4.5	3.4	3.3	2.4	5.2	3	2.4
3.5	4.2	3.2	3.0	2.2			
4	3.9	3.0	2.7	2.1	4.6	2.6	2.3
4.5	3.7	2.9	2.5	2.0			
5	3.6	2.8	2.3	1.9			

Table 1 Modulus of Subgrade reaction (MPa/m)

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Column 8 of Table 1 shows the ks values derived from a plate bearing test on a similar soil profile in Lichfield St. The plate was 0.3m square, so the applied load increases stresses only in the upper soil layer, and will not reflect what happens with larger footings with deeper stress bulbs, but does provide a measure of reality check.

Another method using the SPT N values to estimate the relative density, and from that the modulus of subgrade reaction gives ks = 4.5 – 12 MPa/m for a 2m wide footing, and 4 – 10 MPa/m for a 4m square footing.

Typical values from text books usually give higher values, but these are likely to be for 0.3m square loaded areas on homogeneous soils. When corrected for width and submergence, values are likely to come down to values somewhere in the above range.

Ks is notoriously hard to determine, and the above values are likely to be +/- 50%. I conclude that the values derived from the 1986 report would have been the values I would have recommended at the time.

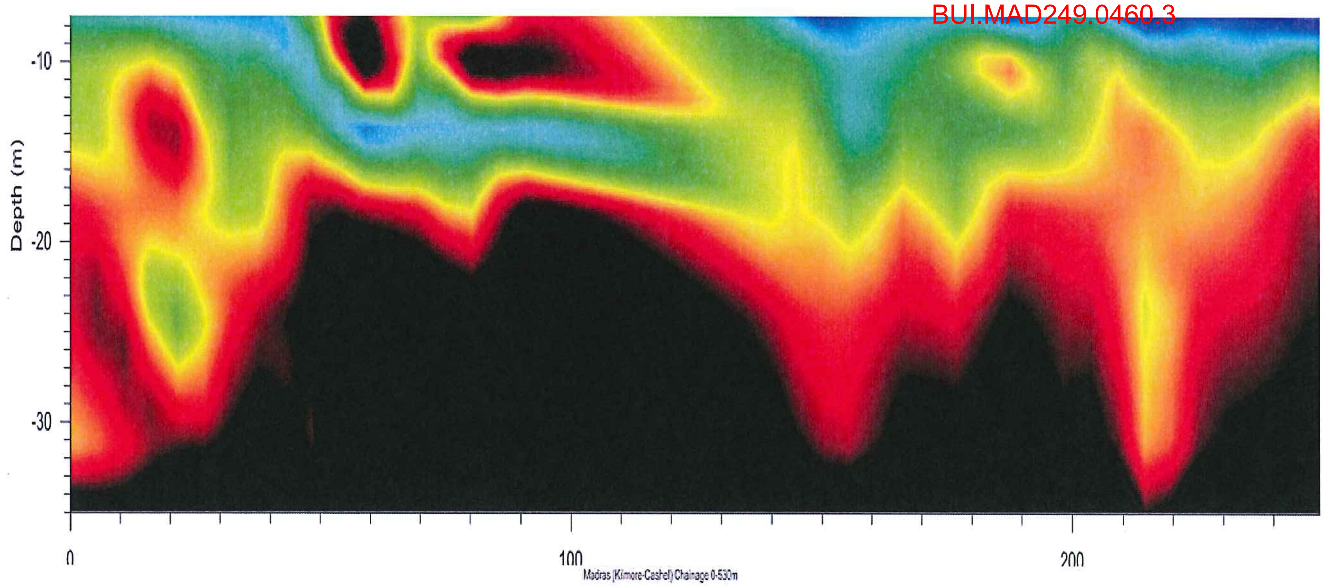
(b) Values used today

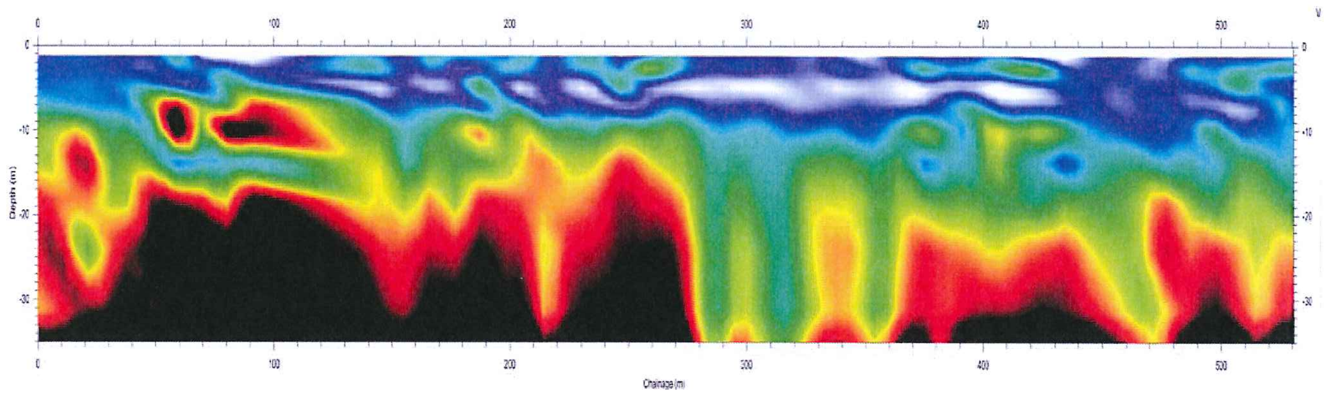
You have asked what values for ks I would suggest for use if the building design was being carried out today. I would still suggest the use of ks values similar to those derived from the 1986 work.

Tonkin and Taylor (T+T) have reported on the site in their letter titled *CTV Building Geotechnical Advice*, dated 11 July 2011, to StructureSmith Ltd. They include a section on subgrade reaction for the dynamic analysis. I am not an expert in this field and do not wish to comment, other than making the comment that with the relatively loose cohesionless soils in Christchurch, seismic shaking appears to have generated high pore water pressures in soils even if there has not been full liquefaction. This must reduce the shear strength of the soil, and the reasoning that subgrade reaction values for dynamic analysis should be expected to be much greater than for static analysis may not be entirely applicable. Dr Kevin McManus has presented an argument to the Royal commission that the use of a strength reduction factor of 0.8 – 0.9 with earthquake overstrength (Table 1 B1/VM4) is unconservative and that a lower value should be used, which is in line with my comments above..

T+T also comment on static subgrade reaction stiffness. They give a range of values of 51 to 116 MN/m^3 for footing type 1 and 10 to 80 MN/m^3 for type 1b (on the area without underlying gravel). These values appear to be derived from published data (Bowles 1988 is referenced). It is unclear whether footing width has been taken into account in their derivation. My understanding, and use of the published data, is that the values are for a standard one foot (0.3m) square plate as traditionally used in plate bearing tests (this was explicit in Bowles 1st edition, 1968, but was not in later editions). Assuming this, then a published value of 80 MN/m^3 becomes about 23 MN/m^3 when corrected for a 4m wide footing. It is also noted that T+T have taken the depth of influence as 3 x footing width. The stress levels are low at this depth and 2x or even 1.5x the footing width are often taken as an effective depth of influence. I conclude that the values suggested by Tonkin and Taylor are high.

The shear wave velocities and derived shear modulus for the site are low in the upper few metres of the site





Based on these shear wave velocities we get the following values for shear modulus (Table2). There is reasonable agreement between the SPT derived values and the MASW derived values in the upper 5 metres of the subsoil on the site (where the SPT tests were made).

Depth	Vs m/s)	P ($x10^3$ kg/m^3)	G (MPa)
0 – 2	160	1.8	46
2 – 4	180	2	58
4 – 6	300	2	180
6 – 8	400	1.8	320
8 – 10	450	1.8	360
10 – 12	420	1.8	320
12 – 14	300	1.8	160
14 – 16	300	1.8	160
16 – 18	420	1.8	320
18 - 20	500	2	500

Table 2 ***Shear Wave velocities and shear modulus (Madras St)***

Yours faithfully
Geotech Consulting Limited

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