Modeling and monitoring of hammer piling induced vibrations

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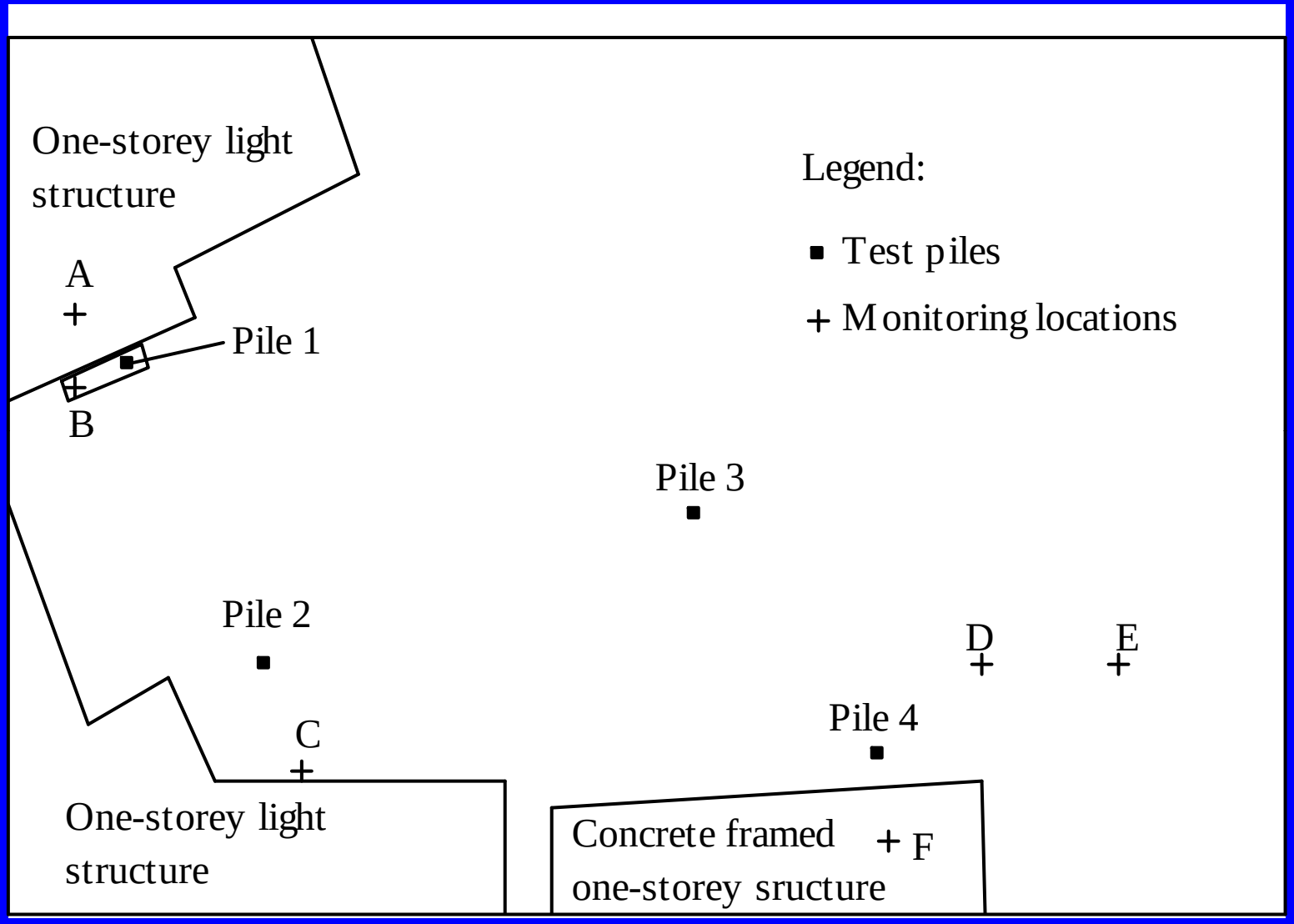

One-storey light structure
A
Pile 1
B
Legend:
Test piles
Monitoring locations
Pile 3
Pile 2
D
E
Pile 4
C
One-storey light structure
Concrete framed one-storey sructure
F

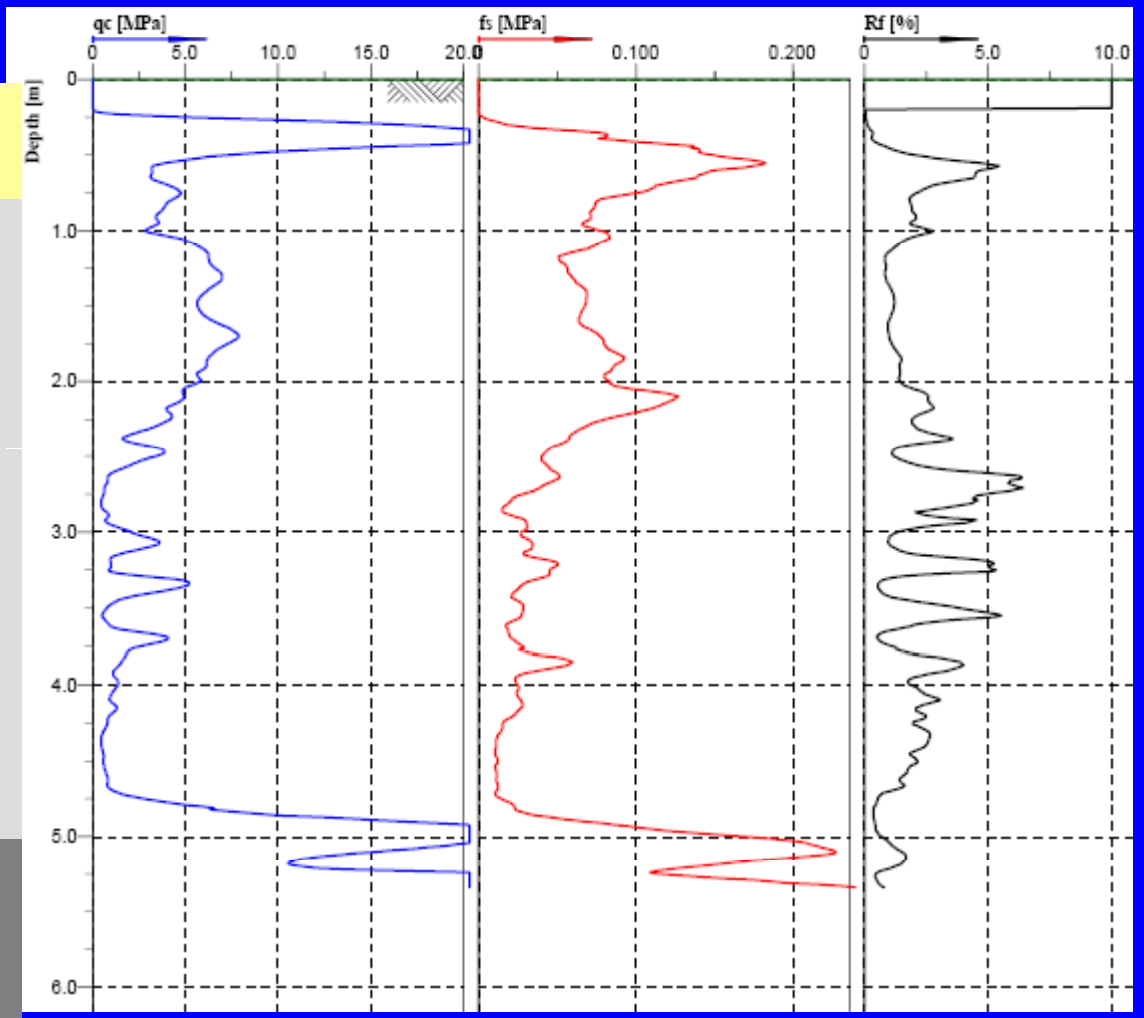
Fill

Pleistocene Age sediments:

stiff to very stiff sandy silt or silty sand

q_c= 1~ 8 MPa

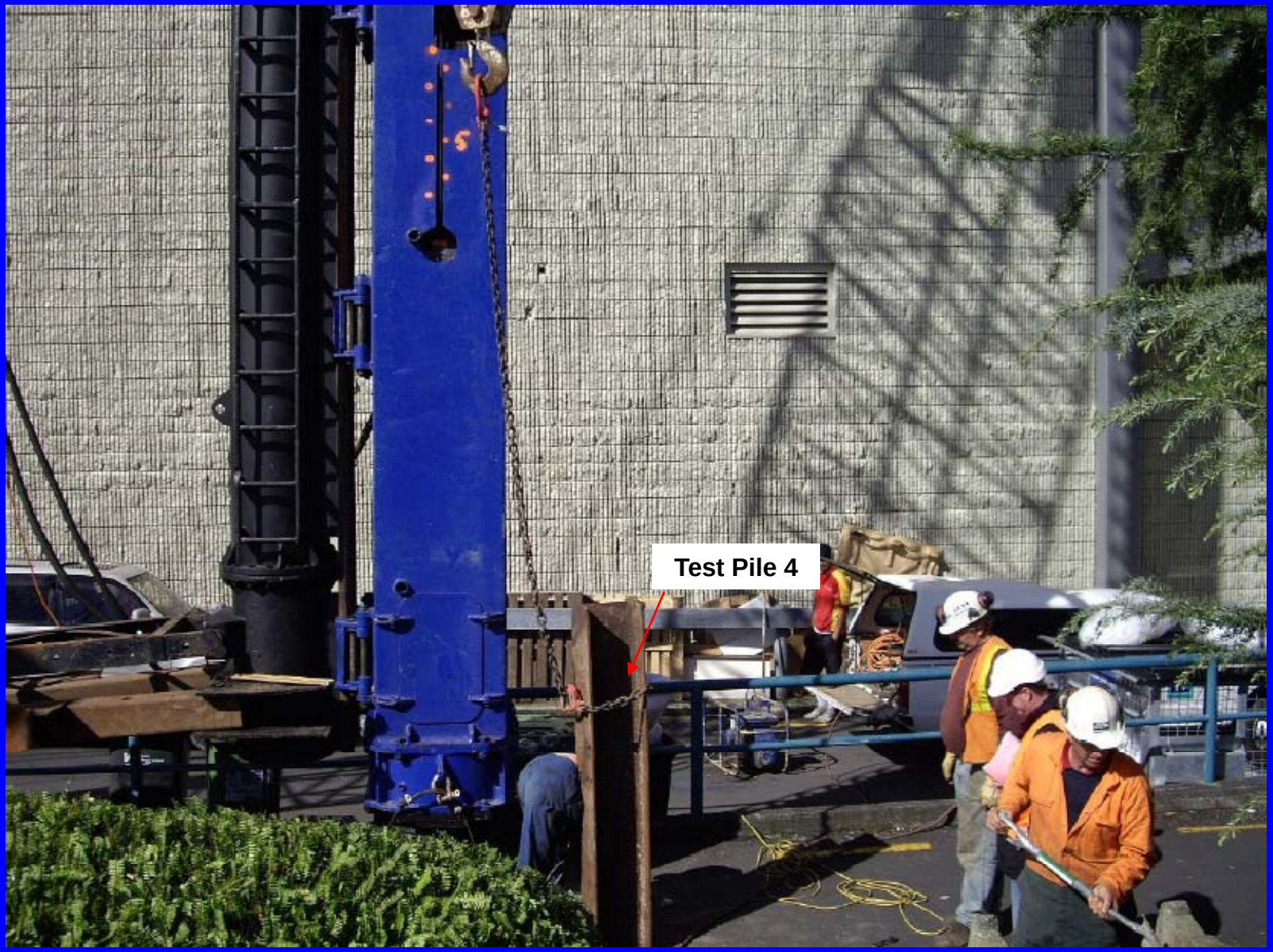
Weakly cemented siltstone or sandstone




7 tonne Junttan hydraulic drop hammer
HYUNDAI


Test Pile 1
(310 UC 97)
Monitoring
Point A

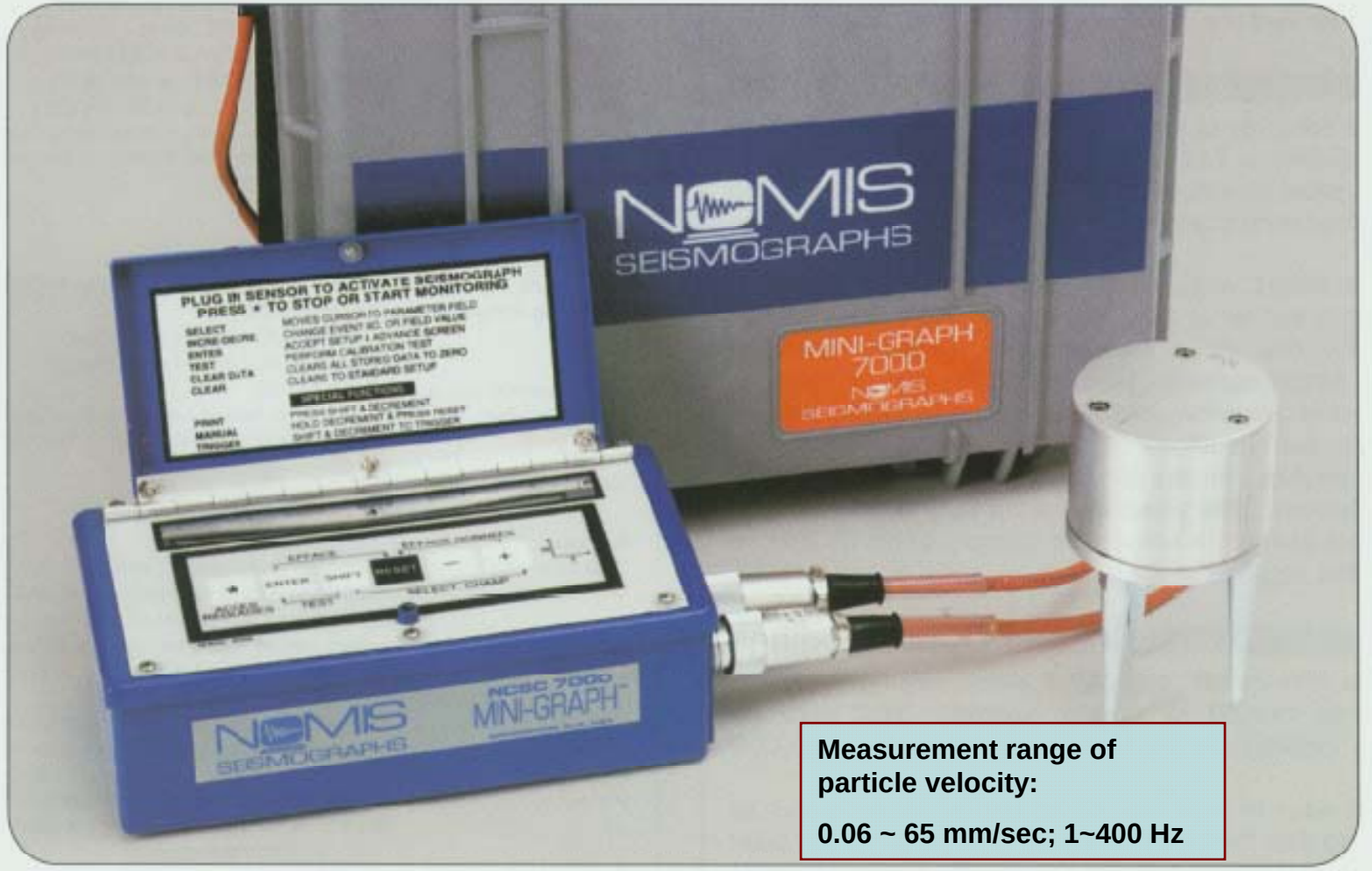
PDA testing at Test Pile 3


Test Pile 4

NOMIS SEISMOGRAPHS

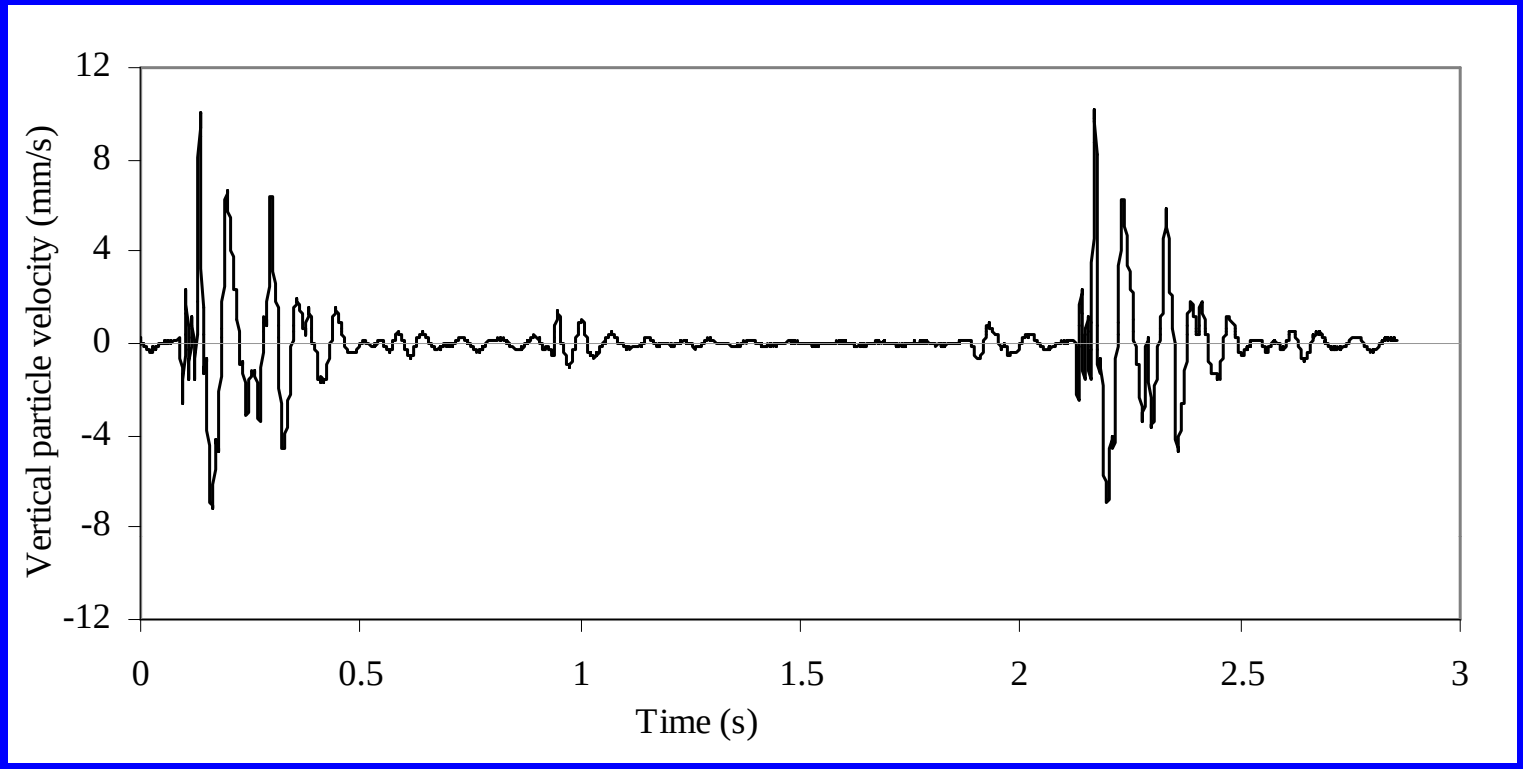
Triaxial transducer

NOMIS Mini-Graph® 7000



Measurement range of particle velocity:

0.06 ~ 65 mm/sec; 1~400 Hz



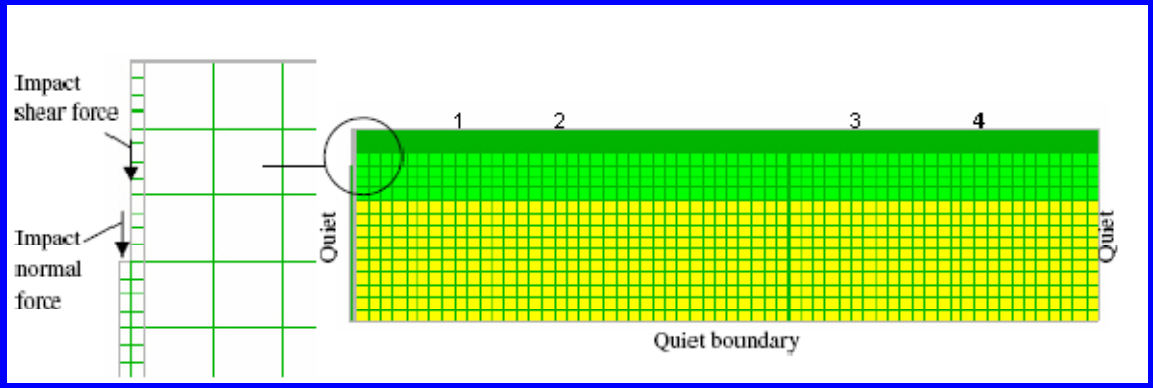
Vertical particle velocity time history

Point A: 9 m from Test Pile 1

Pile depth: 0.5 m

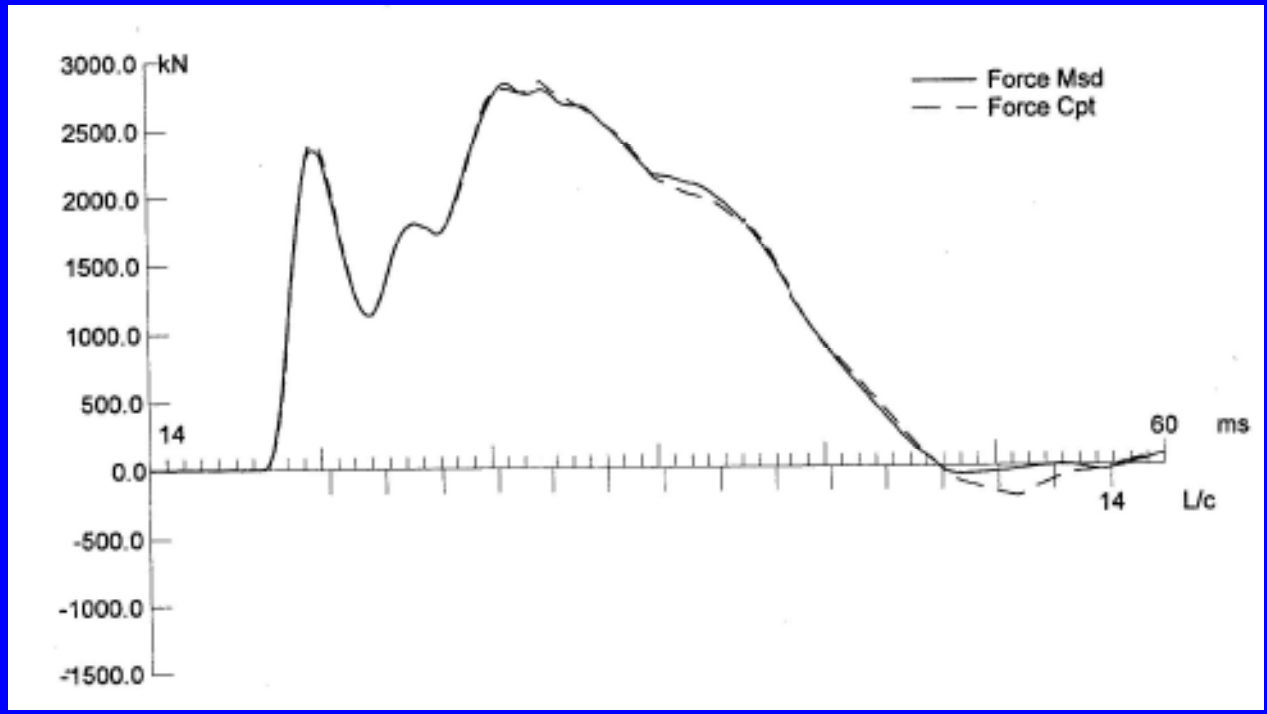
Two blows: 2 sec interval

ppV:10 mm/sec

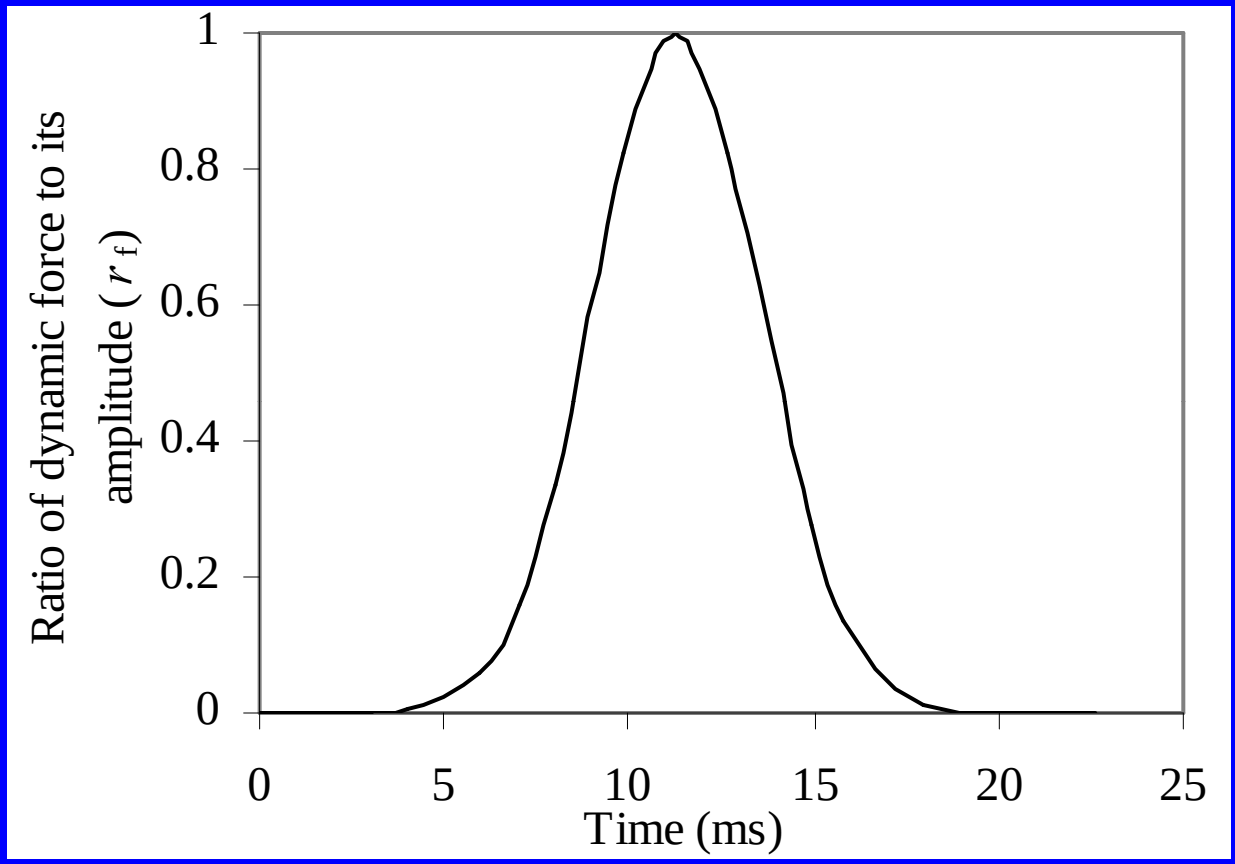


FLAC model

(Axisymmetrical model/elastic soil)

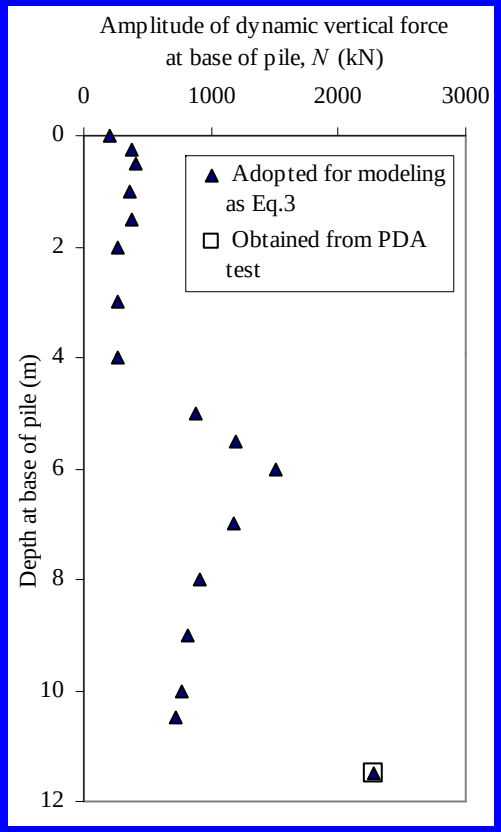


PDA test (Test Pile1)

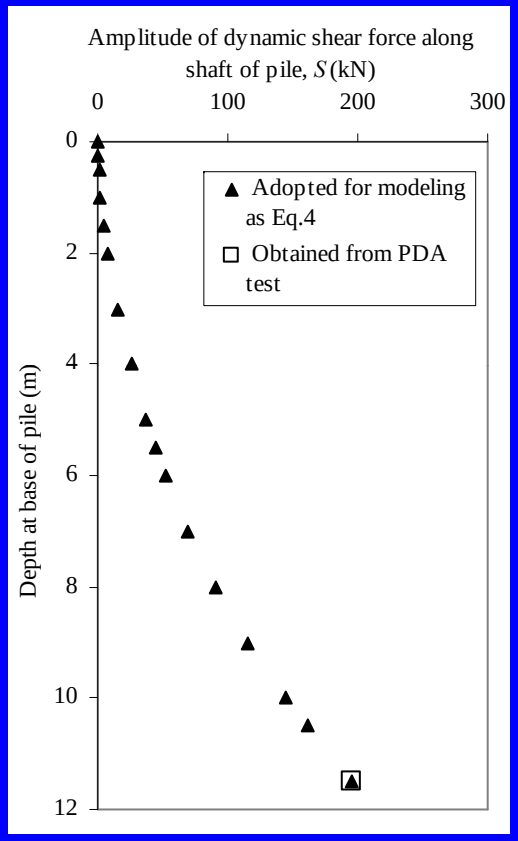


Shape function of dynamic forces

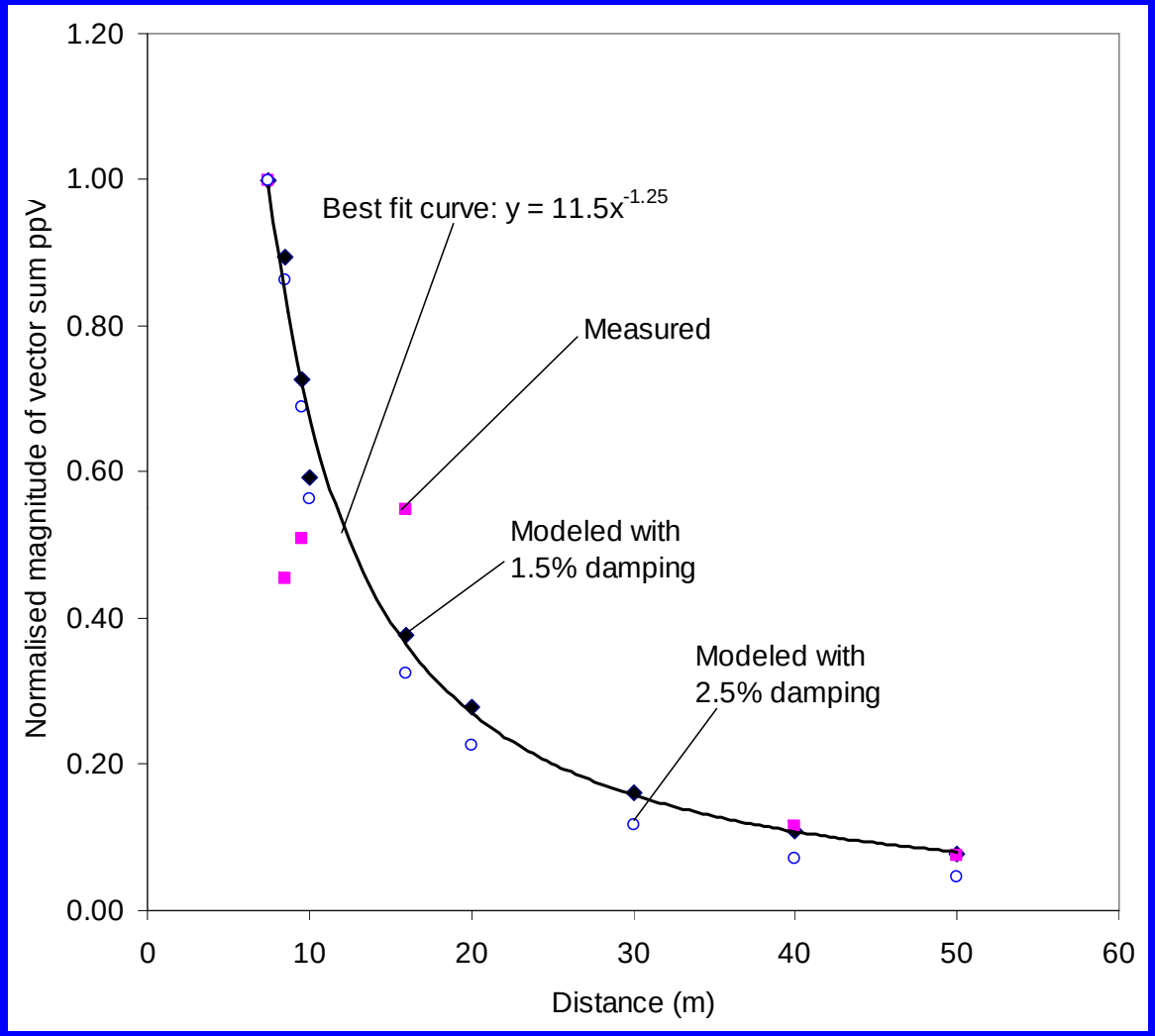
Amplitudes of dynamic forces



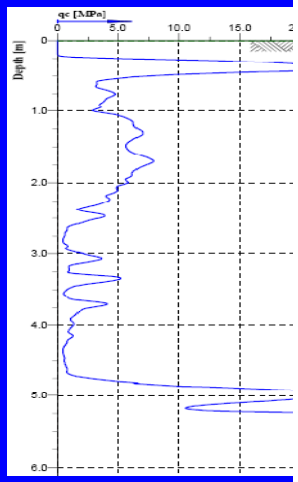
$$N = c_1 c_2 R_b$$

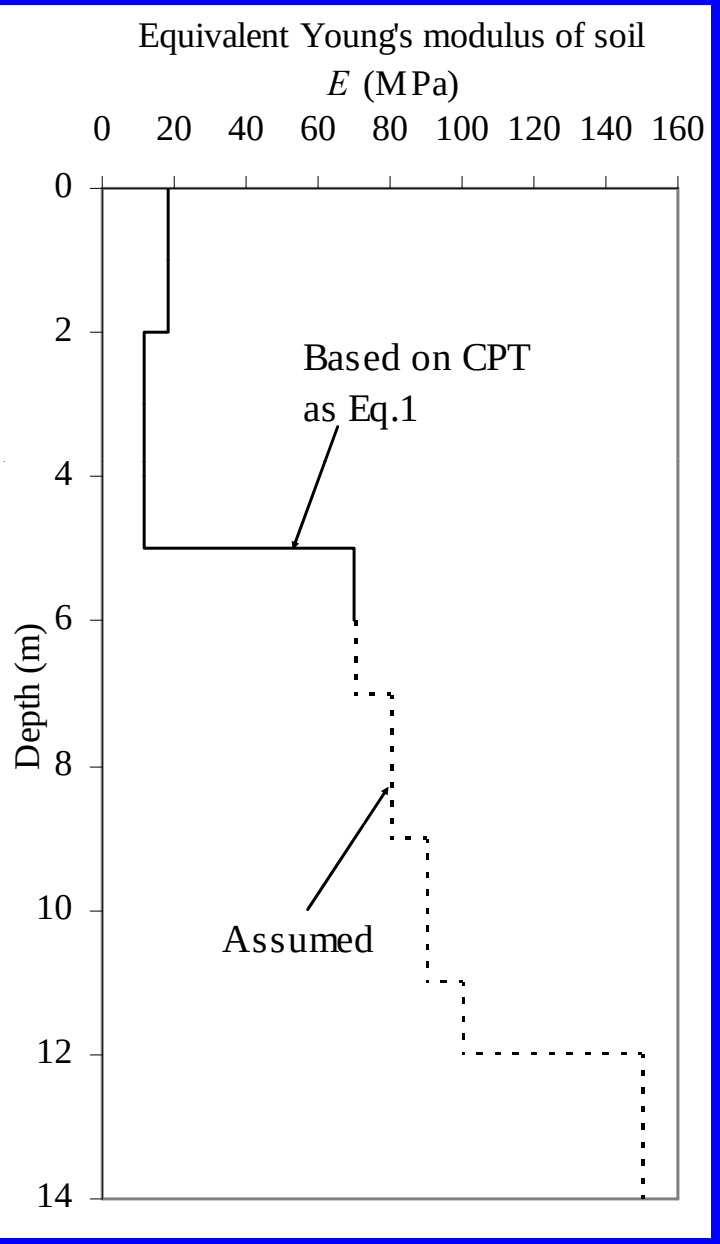


$$S = \pi d f_{PDA} \sum_{i=1}^{n} \frac{\sigma_{vi} \tan(\varphi_i)}{\sigma_{vPDA} \tan(\varphi_{PDA})} h_i$$



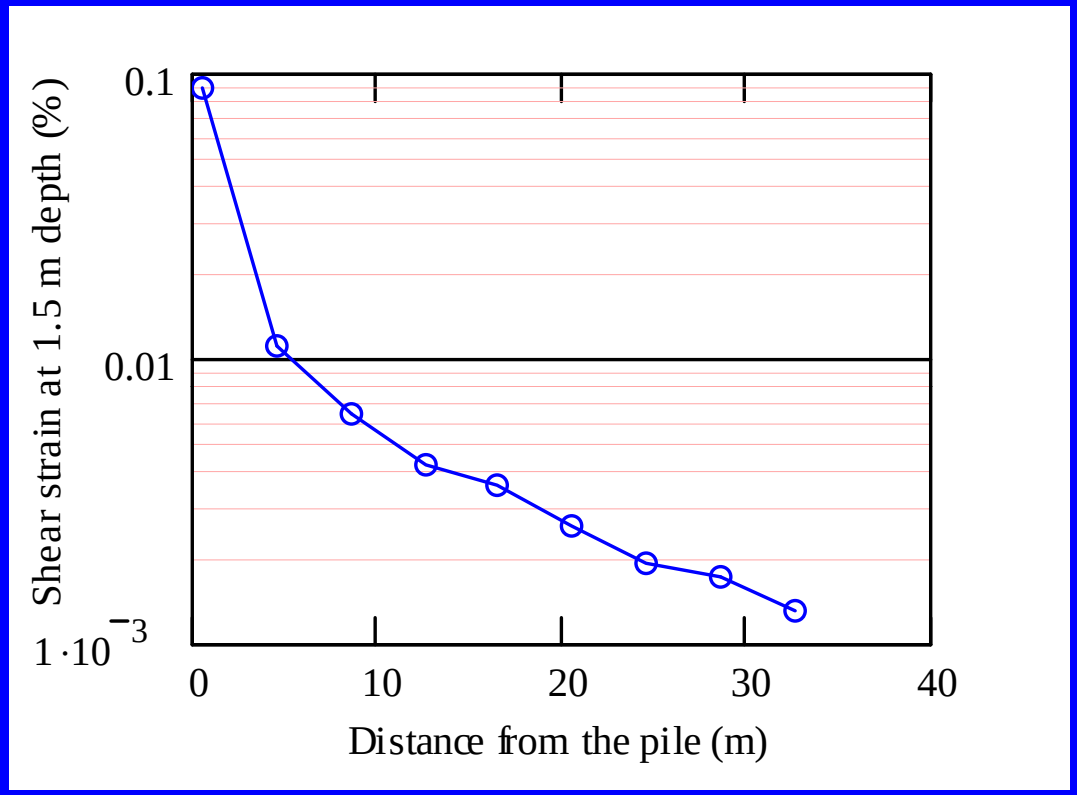
Effects of damping ratio



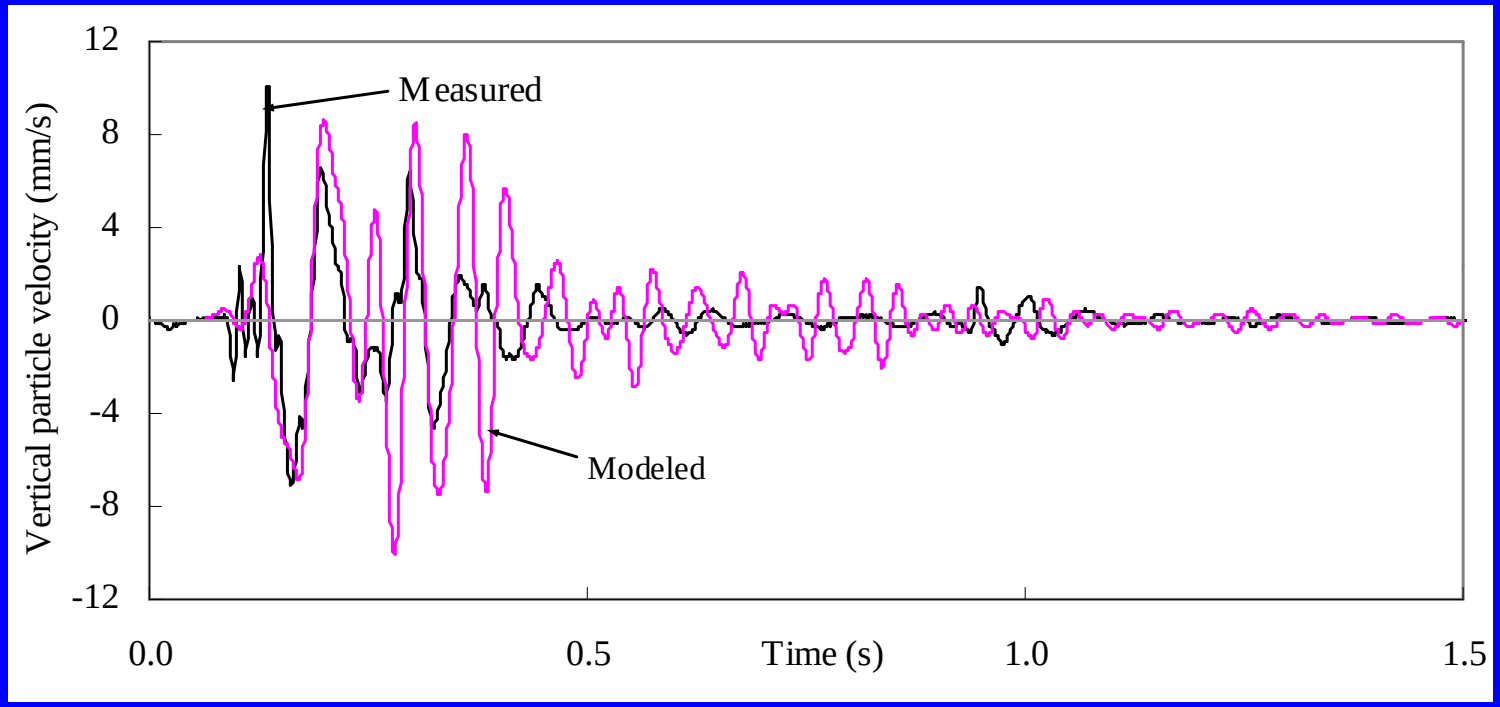


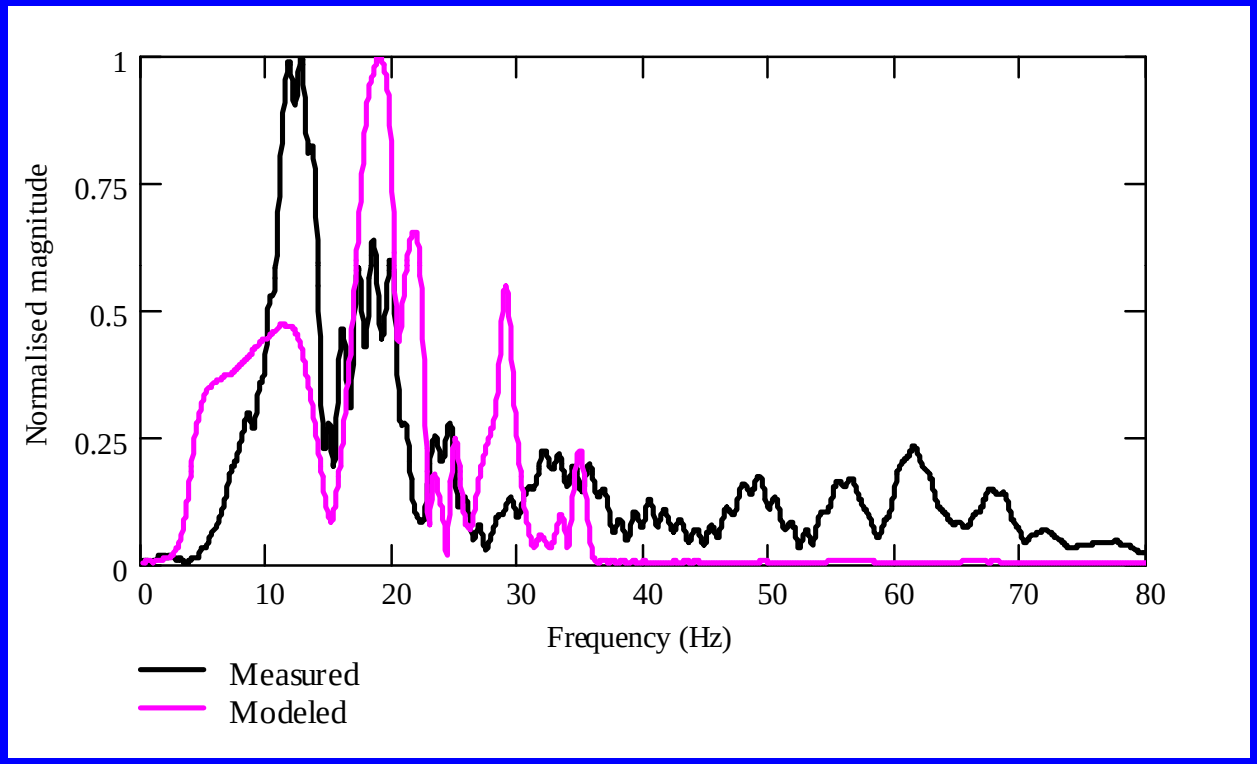
$$E = \alpha(q_t - \sigma_{vo}) \frac{(1+v)(1-2v)}{1-v}$$

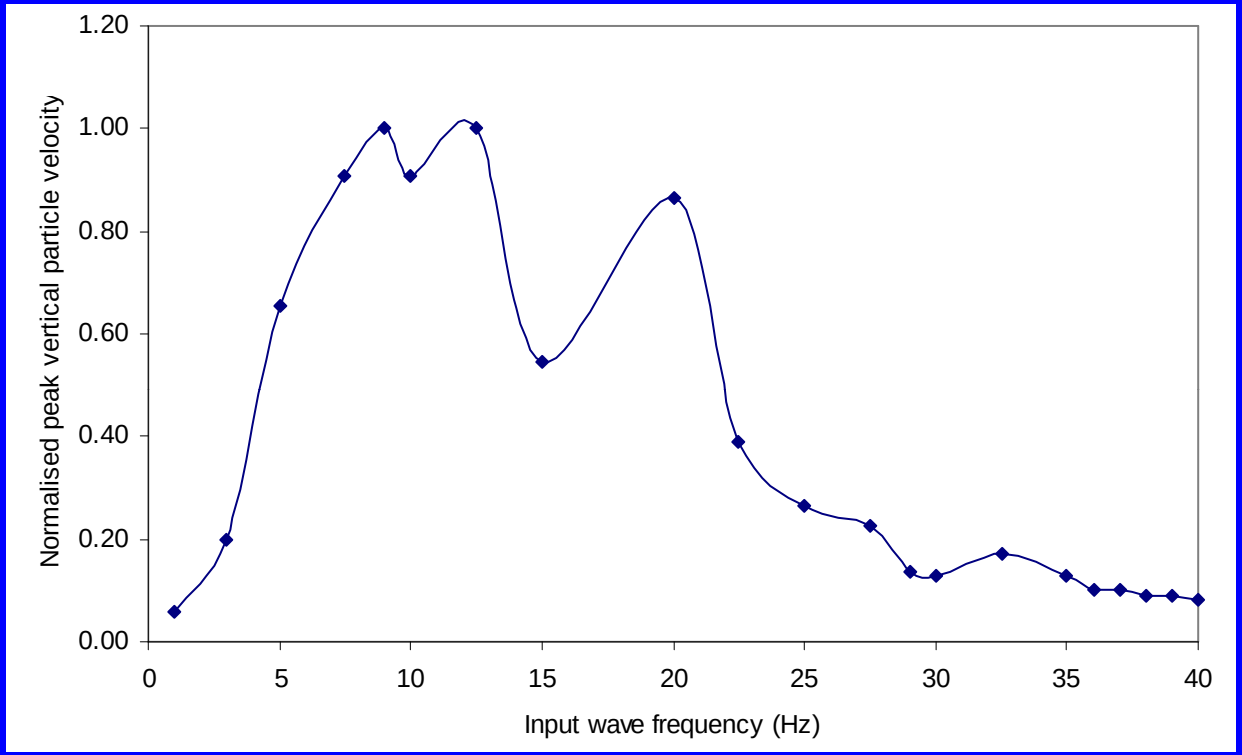
α = 5.4 via trial and error



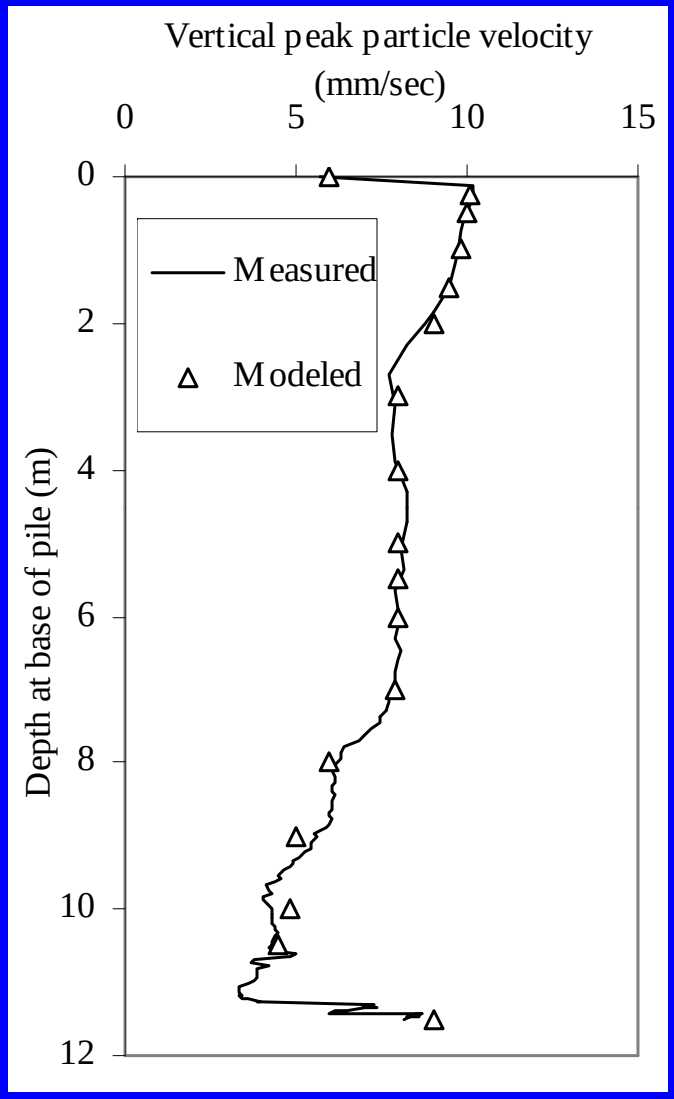
Shear strain level in soil

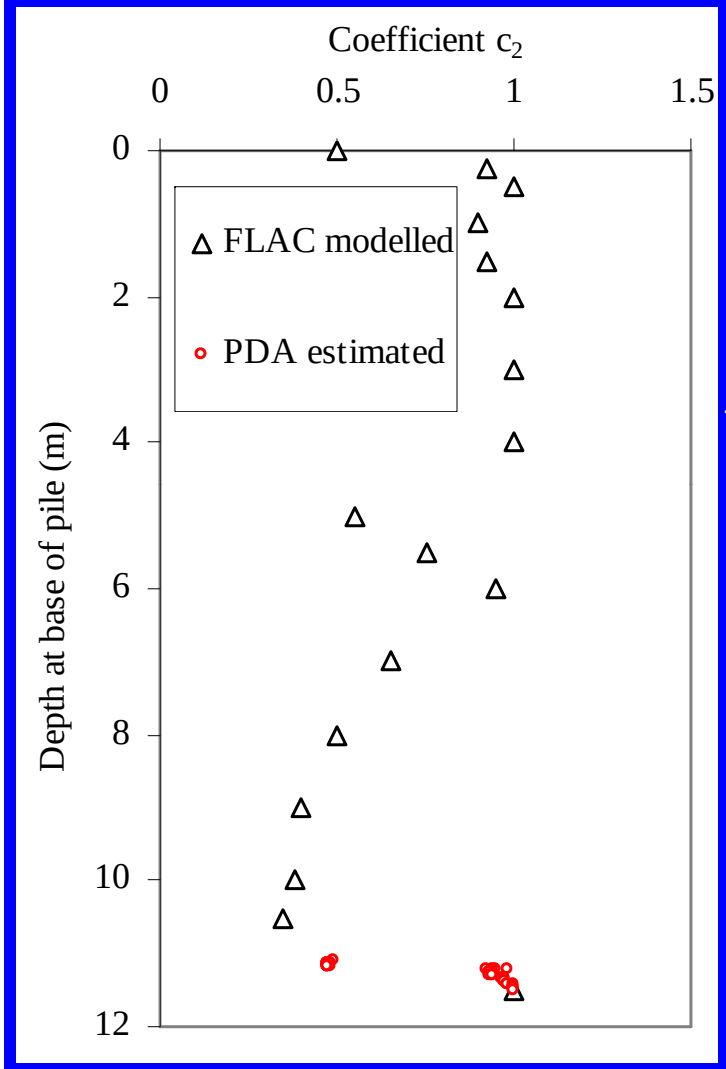

12
8
4
0
-4
-8
-12
Vertical particle velocity (mm/s)
Measured
Modeled
0.0
0.5
Time (s)
1.0
1.5


Normalised magnitude
1
0.75
0.5
0.25
0
0
10
20
30
40
50
60
70
80
Frequency (Hz)
Measured
Modeled

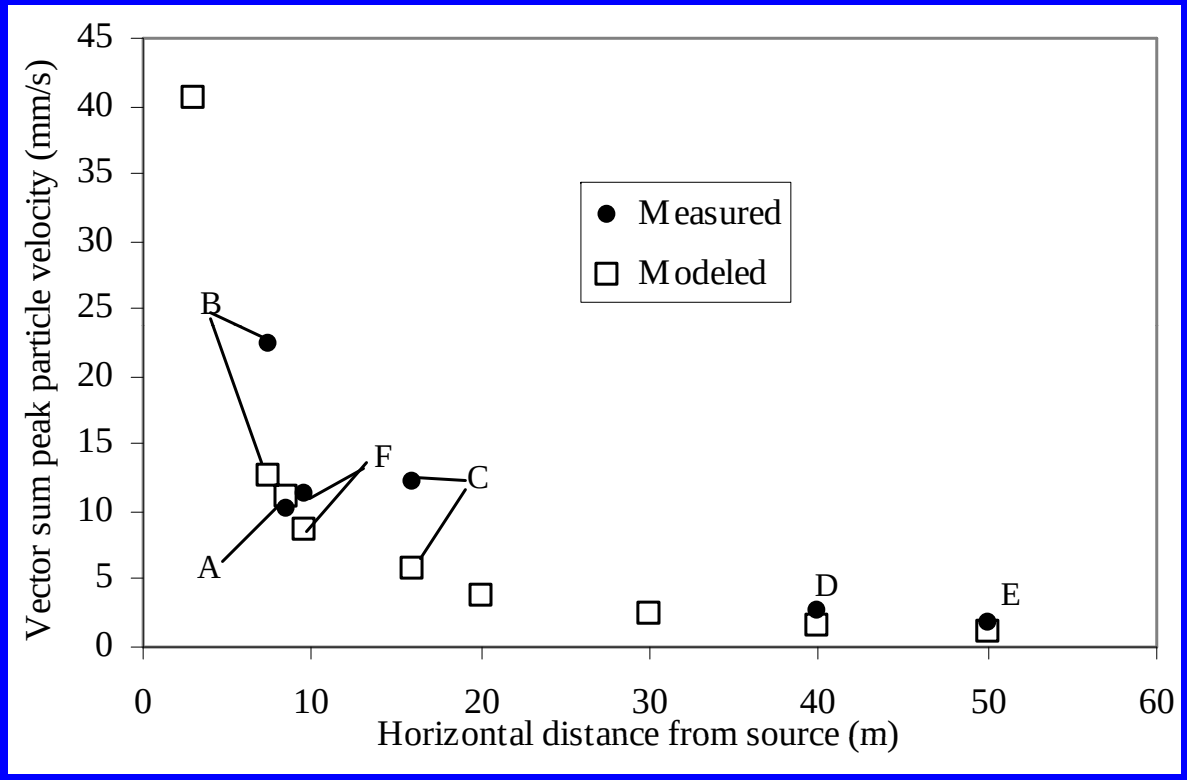


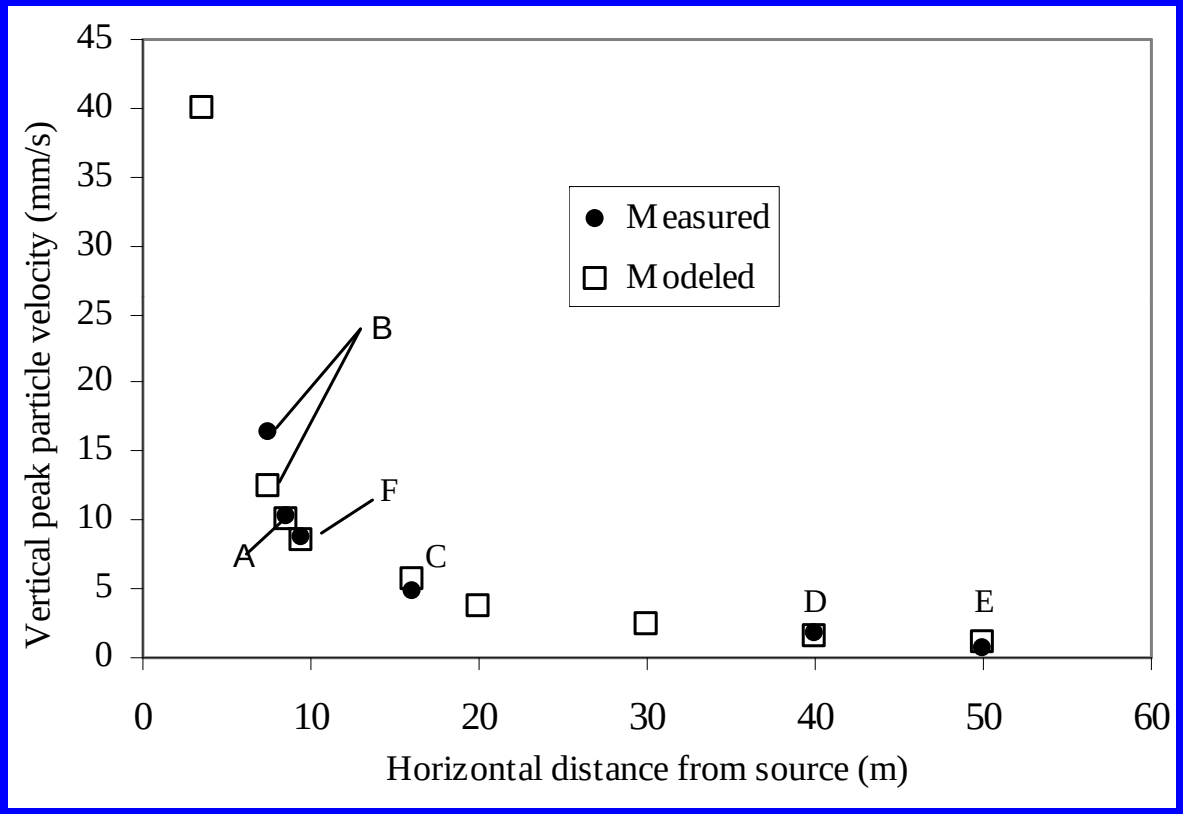
Response of the model to excitation frequency





Hammer falling height ratio


Vector sum peak particle velocity (mm/s)
45
40
35
30
25
20
15
10
5
0
0
10
20
30
40
50
60
Horizontal distance from source (m)
Measured
Modeled
A
B
C
D
E
F


Vertical peak particle velocity (mm/s)
45
40
35
30
25
20
15
10
5
0
0
10
20
30
40
50
60
Horizontal distance from source (m)
Measured
Modeled
A
B
C
D
E
F

Summary

- A simplified FLAC model was used to model ground vibrations caused by a 7 ton drop hammer driving steel piles;
- A linear elastic soil model was considered and an equivalent damping ratio of 1.5% was used;
- Young's moduli of soil were derived from CPT results q_c (coefficient=5.4);
- Peak particle velocity of ground vibrations can be satisfactorily predicted using the simplified elastic model provided appropriate dynamic forces and equivalent soil parameters are used;
- Predominant frequencies of the ground vibrations can also be satisfactorily predicted by the FLAC model but the high frequency components are not adequately predicted by the model due to the limitation of element size (1m).


Farmers