SEISMIC PERFORMANCE OF A SINGLE MICRO-PILE IN LAYERED SOIL

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ISM Workshop, Toronto, September 27, 2007

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INTRODUCTION

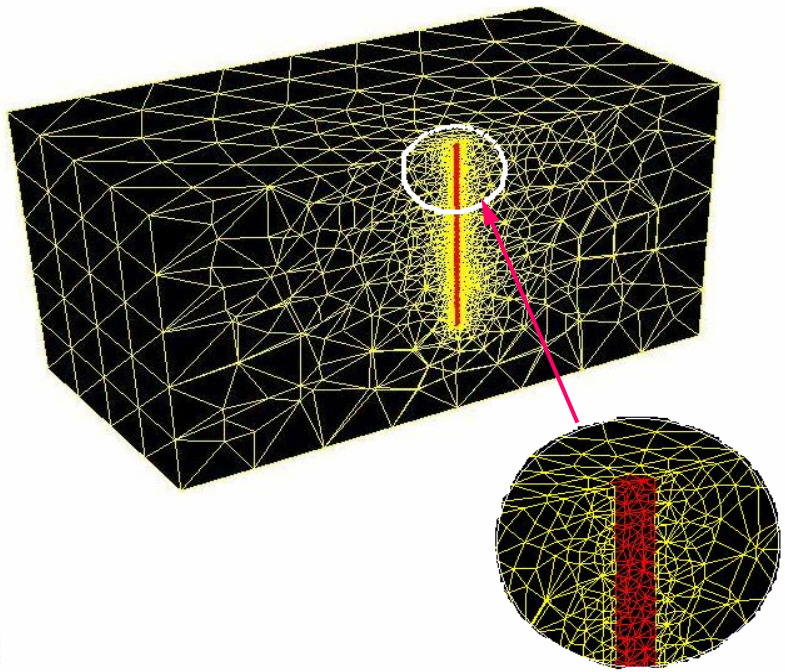
Finite element analyses of seismic response of a single micro-pile performed considering soil nonlinearity.

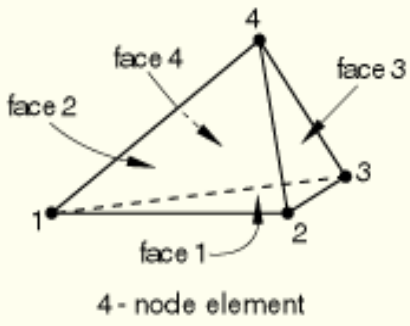
Factors Considered:

- soil plasticity
- Soil layering
- input motion intensity
- pile casing termination
- Boundary conditions

Modelling

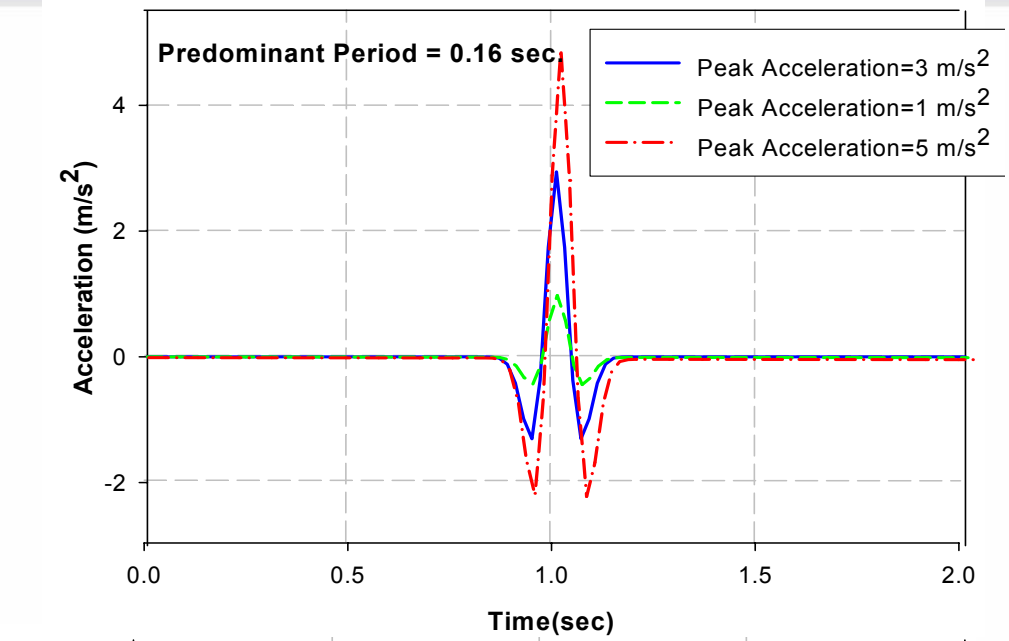
- The soil and pile were modelled using 4-noded linear tetrahedron elements with three degrees of freedom in each node.
- Transmitting boundaries (Wolf and Song, 1996) are used to allow for wave propagation.

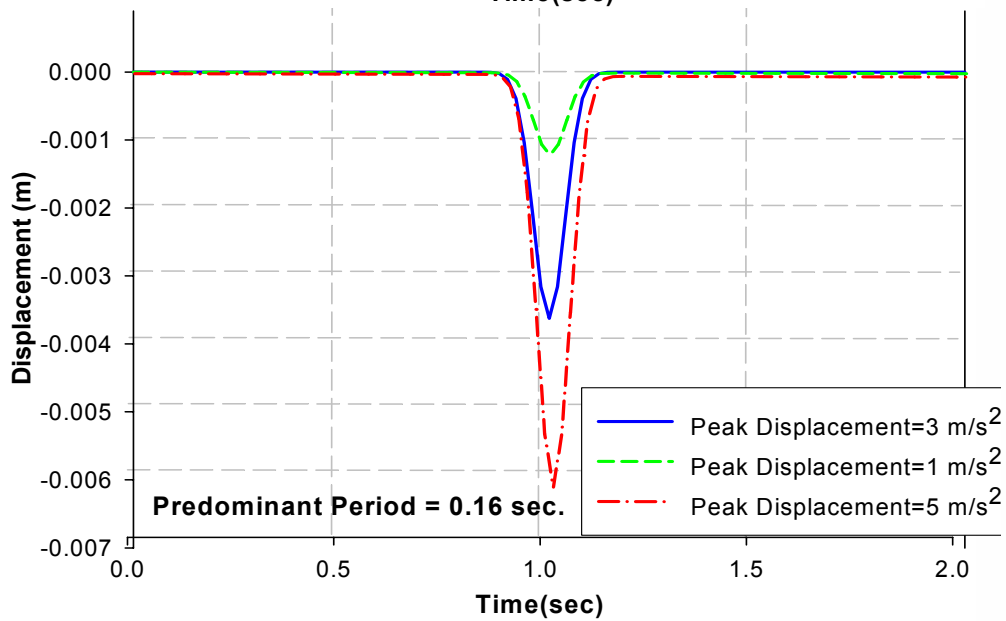




4 - node element

A Ricker wavelet acceleration with 3 m/s^2 peak amplitude and 0.16 sec period is used.





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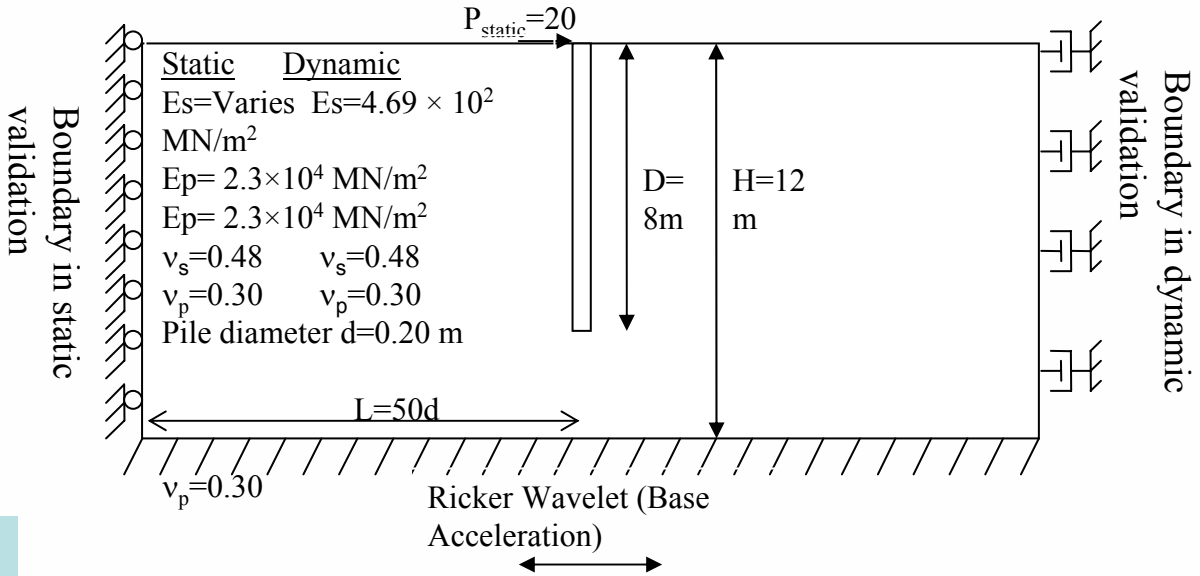
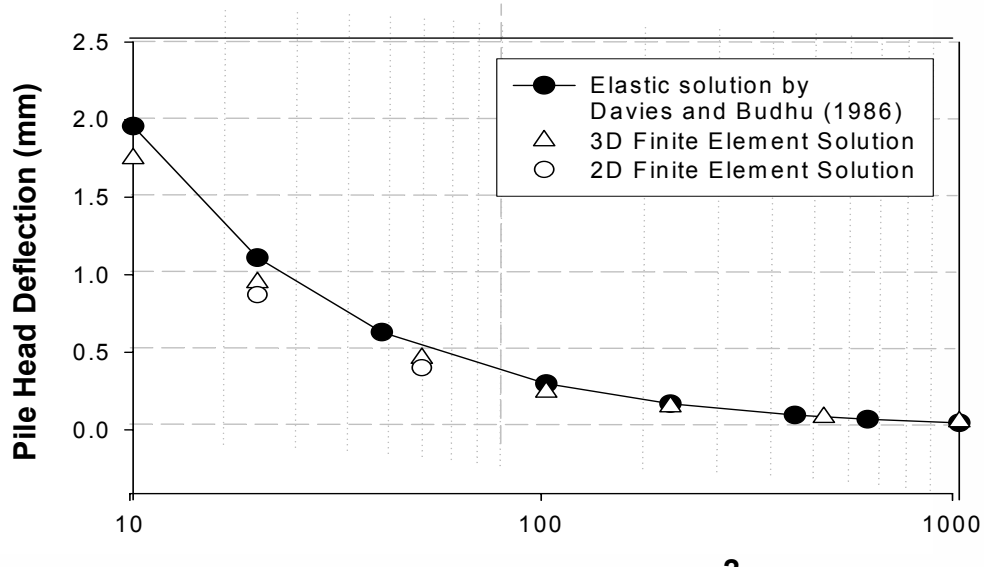
Verification of Model



Static loading



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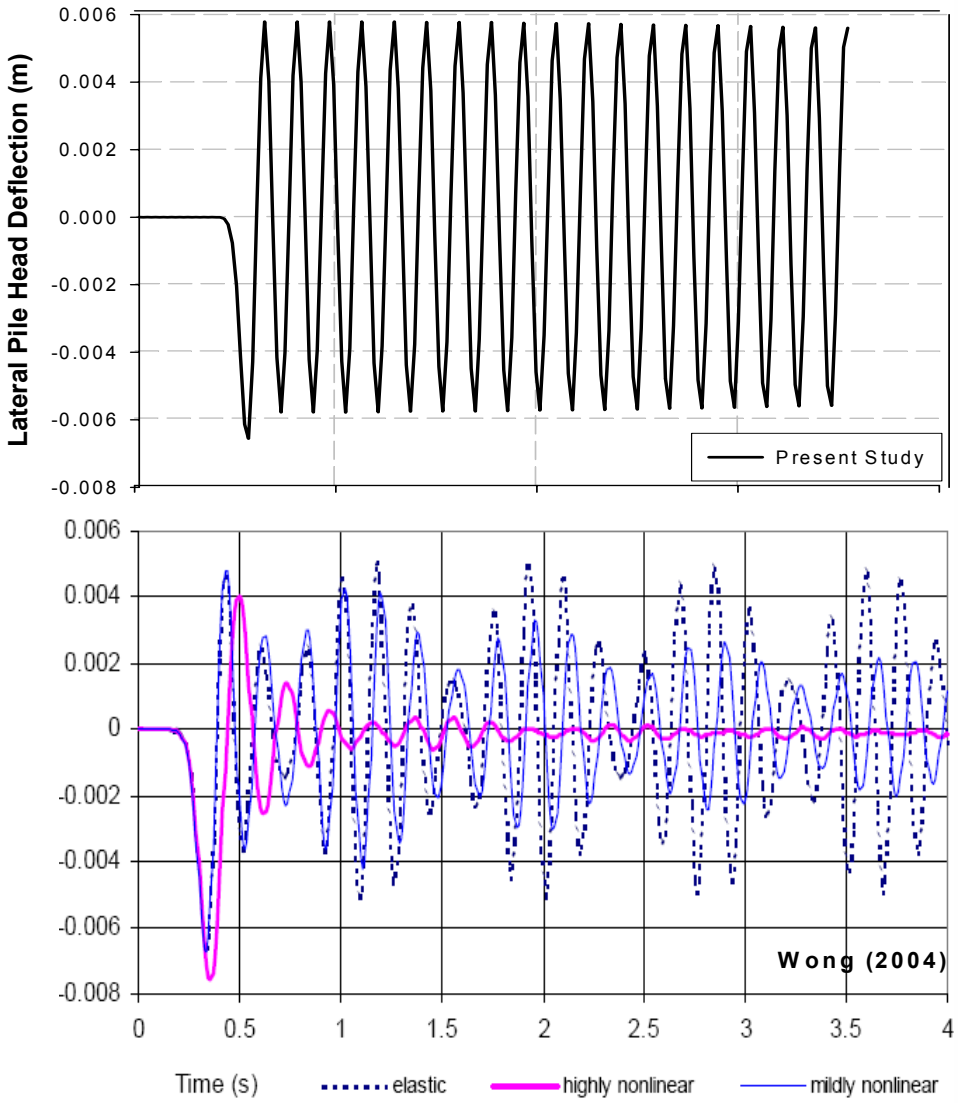
Model Verification

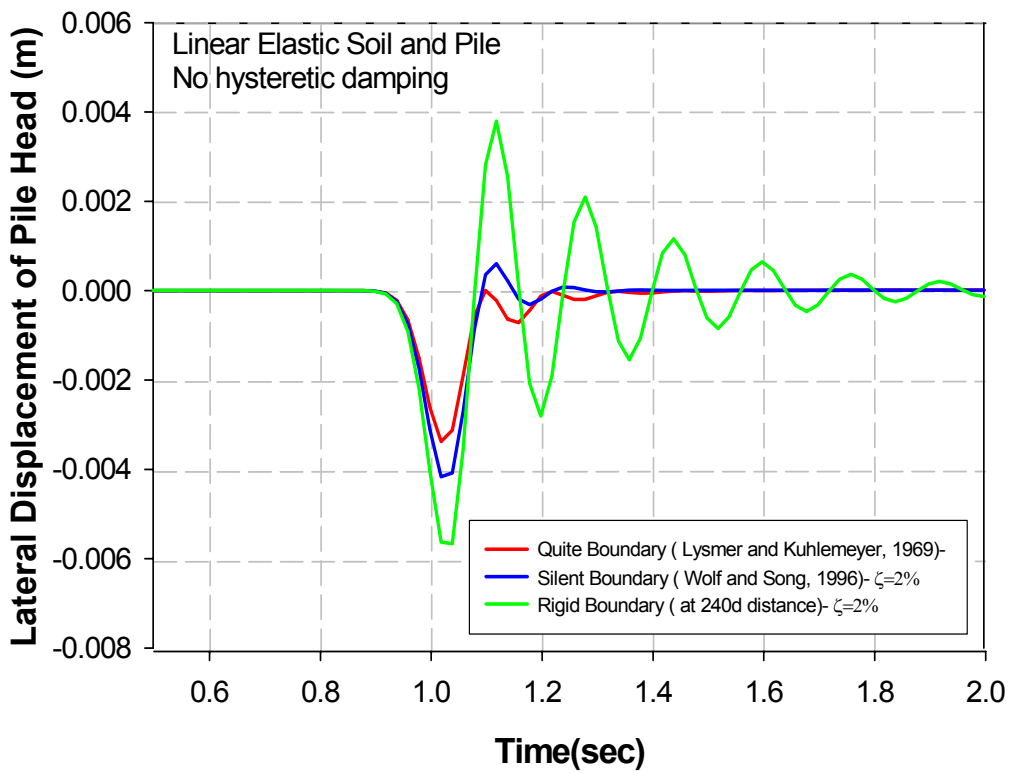
Dynamic loading



Results and Discussion

Effect of Boundary Conditions:

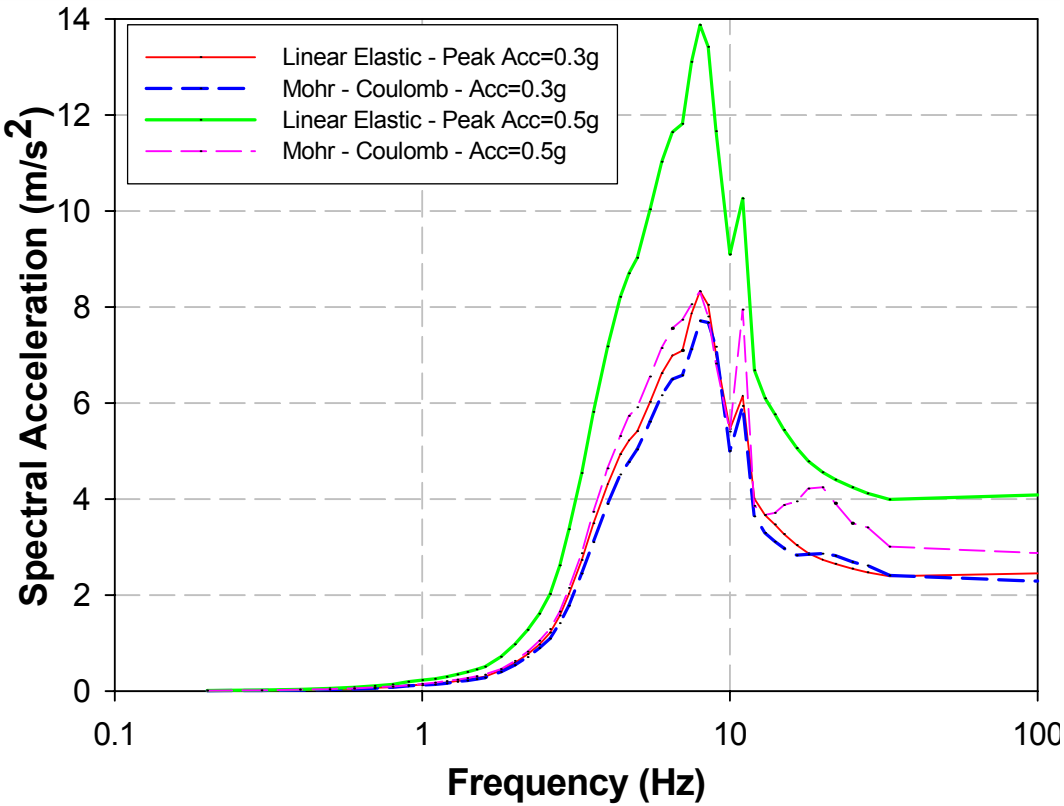
Transmitting boundaries by Wolf and Song (1996) performs better in absorbing energy in comparison with rigid, infinite and transmitting boundaries



Results and Discussion

Soil Plasticity:

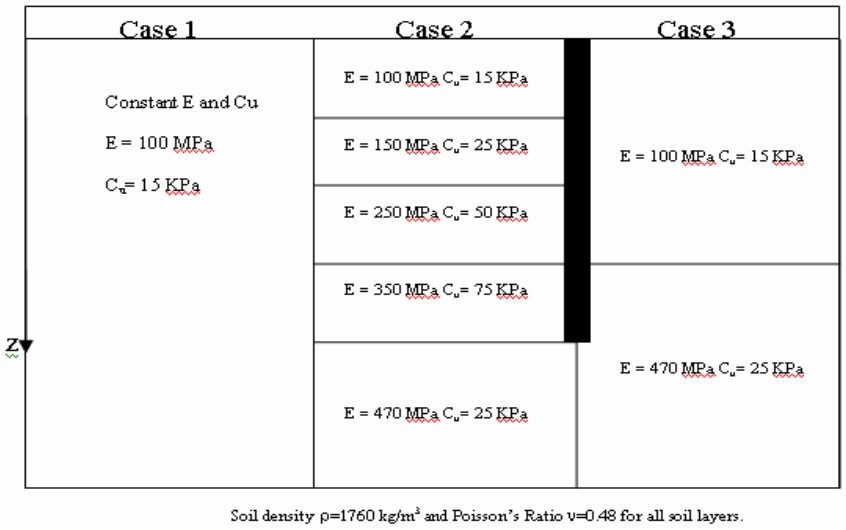
The pile head response decreased due to soil plasticity, particularly evident for strong input motion

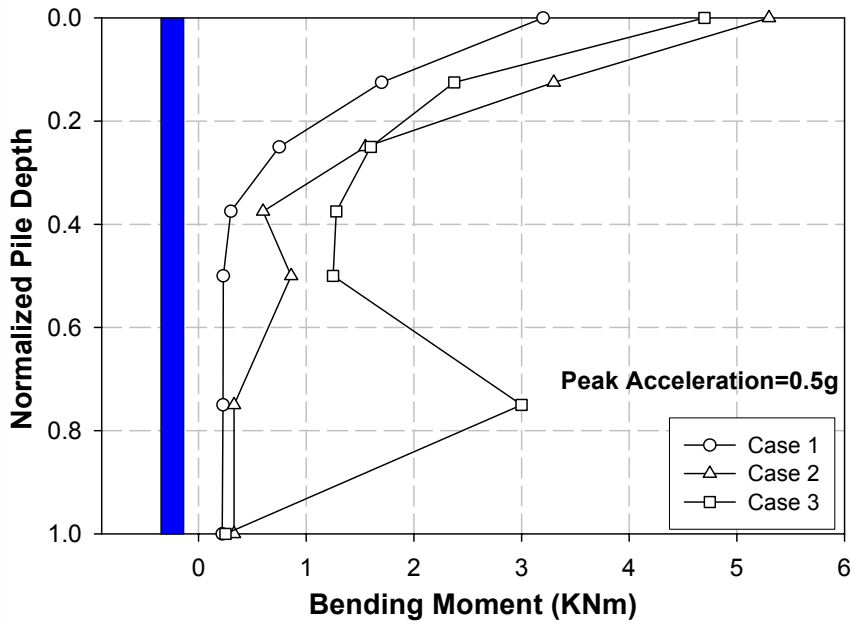


Results and Discussion

Soil layering:

Three different soil profiles are considered





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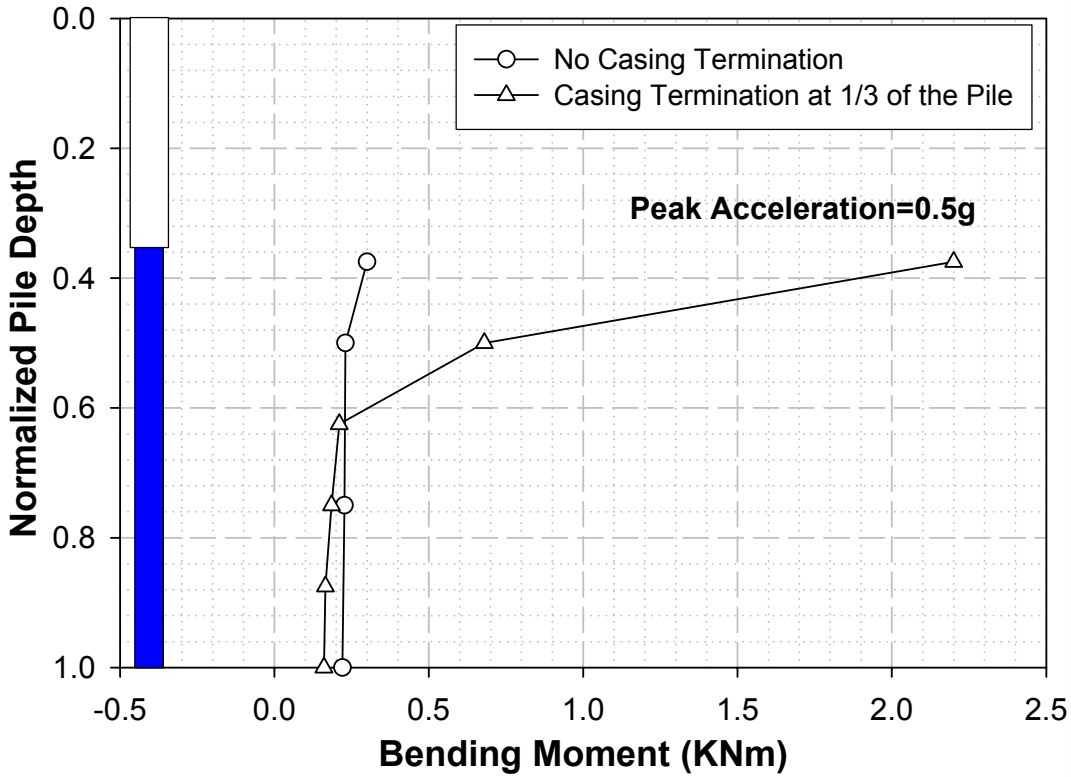
Results and Discussion

Casing Termination During Construction:

Significantly higher bending moments can occur at the point where casing is terminated.



CONCLUSIONS

Transmitting boundaries should be used in modelling problems involving dynamic loading. However, consistent boundaries, which simulate the stiffness of the soil extending to the infinity, should be used for more realistic analyses.

Considering soil nonlinearity leads to more realistic response, resulting in 40 % reduction of the spectral acceleration of the micro-pile head. This is due to the degradation of soil stiffness and increased material damping. The change in the frequency content, however, was insignificant.

With the input motion intensity increasing from 0.3g to 0.5g, the peak spectral acceleration of the pile head increases 1.67 times for elastic soil and only 1.09 times for plastic soil. The effects of the soil plasticity are significant and they should be accounted for in the analyses.

CONCLUSIONS

The bending moments decreased with increasing depth. The variation of bending moments remained insignificant to a depth 0.4 pile length. Bending moment is larger for piles in stiffer soil stiffness. Thus, to obtain a realistic response a realistic soil profile with increasing stiffness with depth should be considered in the analyses.

When the pile toe penetrates through two layers with significant contrast in stiffness, high bending moments develop at the interface of the two layers, and should be considered in design of micropiles.

The casing termination resulted in significant increase in the bending moments at the point of termination. The bending moment at this point was 7.3 times higher than the no-casing termination case.

Thank You