Lateral Loading under reinforced piled embankments

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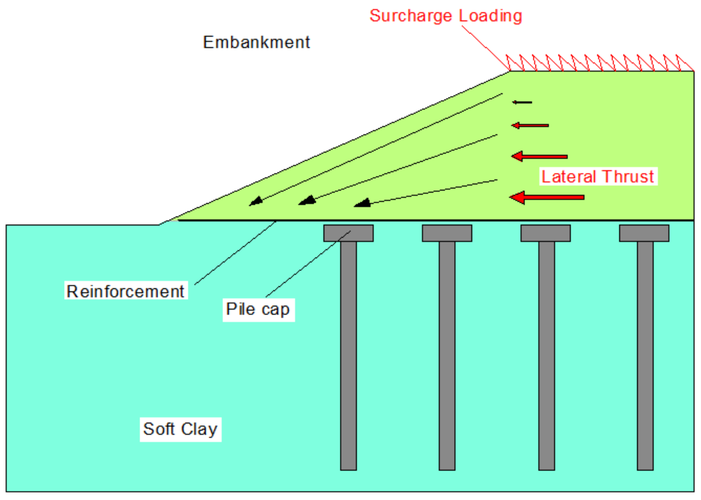


Figure 1. Reinforced pile embankment

Introduction

Piled embankments are widely used for the construction of roads and rails over soft and/or compressible soils. Traditional design methods, such as BS 8006 assume that the lateral trust is carried by geosynthetic reinforcement placed at the base of the embankment directly over the pile caps. At the extremities of the embankment both horizontal equilibrium and strain compatibility between the different components, the embankment fill, the geosynthetic reinforcement, the pile group and the soft soil, must be achieved.

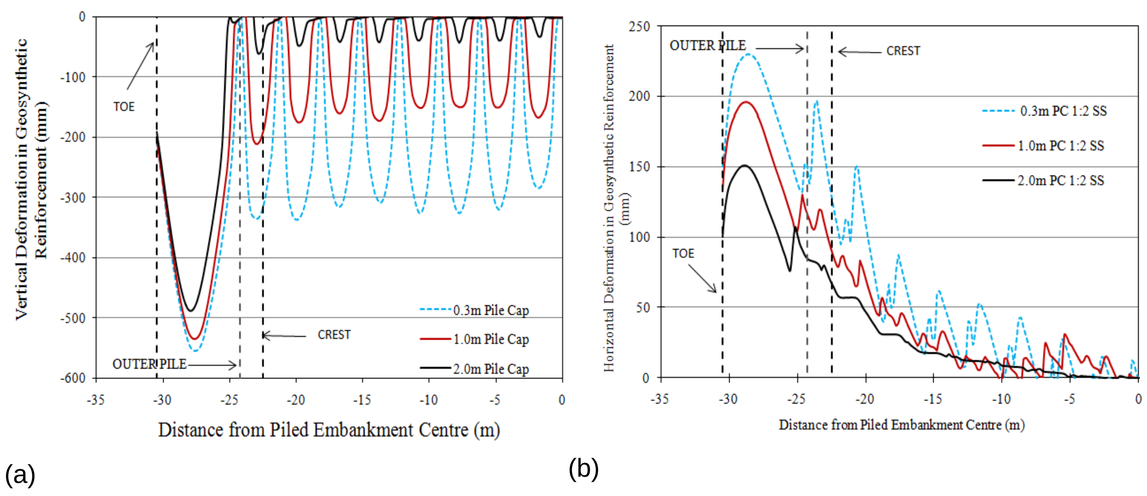
The aim of this research was to:

- Present the results of a plane strain finite element parametric study of the lateral deformational response under the side slopes of reinforced piled embankment and
- Expressions are to be developed giving the degree of support to the limit equilibrium approach offered by the pile geometric characteristics (pile length, pile cap size) (Figure 1)

Results

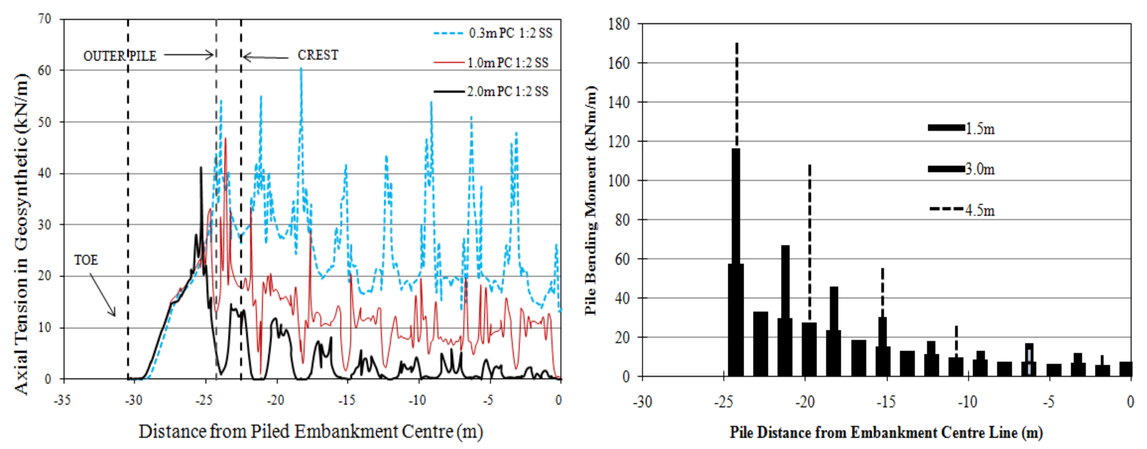
A plain strain finite element parametric study was performed by utilizing Plaxis 2D v9.0 software code. The main findings of the research were:

- The vertical deformation of the geosynthetic reinforcement increased for an increase of embankment height, pile spacing and a decrease of pile cap size. The maximum vertical deformation was located near the embankment toe for all cases (Figure 2(a)).
- The horizontal deformation increased for a decrease in the size of the pile cap (Figure 2(b)), an increase in the pile spacing, the steepness of the side slope. The horizontal deformation also increased for an increase in the embankment height but only increased marginally for greater depth of the underlying soft soil.
- Tension in the reinforcement increased linearly for a pile spacing increase, embankment height, soft soil depth, stiffness of the reinforcement, steepness of the side slope and a decrease in the pile cap size, (Figure 3(a)).
- The bending moment/deflection for all piles under the embankment structure increased for an increase in the embankment height, pile spacing (Figure 3(b)), the steepness of the side slope, decrease in the stiffness of the reinforcement and the depth of soft soil.
- The ratio of improvement with regard to horizontal versus vertical deformation at the crest origin was linear and almost proportional for an increase in the stiffness of the geosynthetic reinforcement and a decrease in the depth of the underlying soft soil. A reduction in the steepness of the side slope yielded a notable improvement in the horizontal deformation whilst having an insignificant influence on the vertical deformation, (Figure 4).



(a) (b)

Figure 2. Vertical deformation of reinforcement for a range of pile cap size (b) Horizontal deformation of reinforcement for a range of pile cap sizes.



(a) (b)

Figure 3. (a) Axial tension in geosynthetic reinforcement for a range of pile cap sizes; and (b) Pile bending moments within pile group for a range of pile spacing.

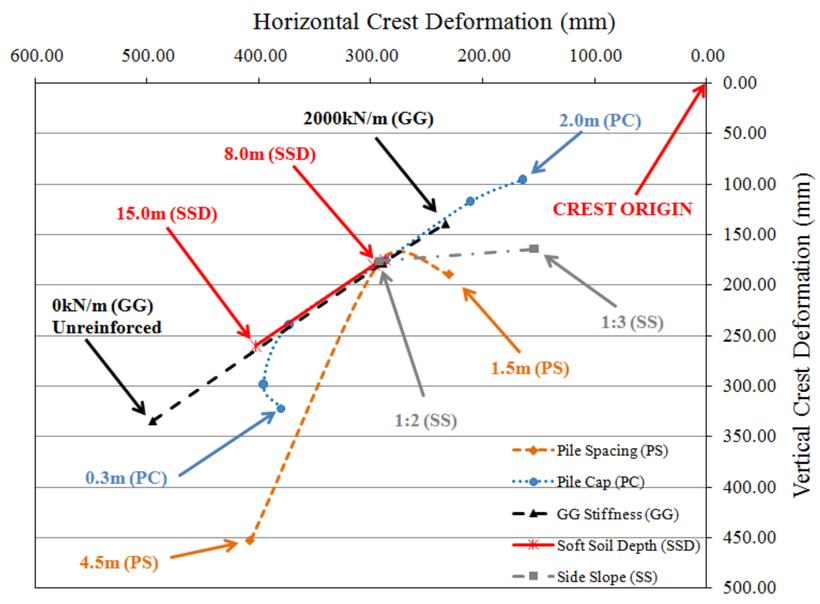


Figure 4. Relationship of crest deformation for a range of parametric variations

Conclusions

- Analysis indicates that significant horizontal and vertical deformation occur in the reinforcement under the side slopes of piled embankments.
- The bending moment and pile head deflection for both the pile group and the outer pile only increased for the same parametric conditions as that of the vertical/horizontal deformation
- The vertical deformation increased significantly from the outer row pile towards the toe of the embankment. Slope stability dictates an extension of the outer row pile towards the toe is required.

References

British Standard BS 8006. (1995). “Code of practice for strengthened/reinforced soils and other fills.” *British Standard Institution*, London, 162.

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