

## Numerical Back-Analysis of PVD-Improved Ultra-Soft Clay Considering Smear Effects: A Case Study from Mae Moh Mine

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### Abstract

Ultra-soft clay at the Sump 1 C1 area of Mae Moh lignite mine requires ground improvement before inside-dump backfilling can be safely undertaken. Located in Mae Moh District, Lampang Province, northern Thailand, Mae Moh is a major open-pit mine and an important case study in mine rehabilitation on ultra-soft ground. This study performed a numerical back-analysis of prefabricated vertical drain (PVD) improved ultra-soft clay under staged loading to investigate the importance of accounting for smear effects. A three-dimensional finite element model was developed in PLAXIS 3D based on field conditions from a test embankment, and the model parameters were back analyzed against monitored settlement behavior. The analysis first evaluated the ground response without smear effects and then examined different levels of permeability reduction in the smear zone using the ratio of horizontal permeability in the undisturbed zone to that in the smear zone ( $k_h/k_s$ ). The results showed that the model without smear effects could reproduce the final settlement, but it substantially overestimated the settlement rate during the early stages of consolidation. When smear effects were included, the predicted response became more consistent with the observed field behavior. Among the cases examined,  $k_h/k_s$  equal to 3 provided the best overall agreement with monitored settlement trends throughout all loading stages. These findings indicate that matching the final settlement alone is insufficient for reliable back-analysis of PVD improved soft ground. Incorporating smear effects is essential for achieving more realistic time-dependent predictions and provides a practical basis for geotechnical analysis and design in mine rehabilitation projects and other construction works on ultra-soft clay.

### Keywords

Prefabricated vertical drains, smear effect, ultra-soft clay, finite element modeling, consolidation.