

Use of Bamboo Piles in Ground Improvement Design: Case Study

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Abstract : A major offshore reclamation work is currently underway in Southeast Asia for a container terminal. The total extent of the reclamation extent is 2600m x 800m and the seabed level is around -5mRL below mean sea level. Subsoil profile below seabed comprises soft marine clays of thickness varying from 8m to 15m. To contain the dredging spoil within the reclamation area, perimeter bunds have been constructed to +2.5mRL. They include breakwaters of trapezoidal geometry, made of boulder size rock along the northern, eastern and western perimeters, with a sand bund along the southern perimeter. Breakwaters were constructed on a composite bamboo pile and raft foundation system. Bamboo clusters 8m long, with 7 individual Bamboos bundled together as one, have been installed within the footprint of the breakwater below seabed in soft marine clay. To facilitate drainage two prefabricated vertical drains (PVD) have been attached to each cluster. Once the cluster piles were installed, a bamboo raft was placed as a load transfer platform. Rafts were made up of 5 layers of bamboo mattress, and in each layer bamboos were spaced at 200mm centres. The rafts wouldn't sink under their own weight, and hence, they were sunk by loading quarry run rock onto them. Bamboo is a building material available in abundance in Indonesia and obtained at a relatively low cost. They are commonly used as semi-rigid inclusions to improve compressibility and stability of soft soils. Although bamboo is widely used in soft soil engineering design, no local design guides are available and the designs are carried out based on local experience. In June 2015, when the 1st load of sand was pumped by a dredging vessel next to the breakwater, a 150m long section of the breakwater underwent failure and displaced the breakwater between 1.2m to 4.0m. The cause of the failure was investigated to implement remedial measures to reduce the risk of further failures. Analyses using both limit equilibrium approach and finite element modelling revealed two plausible modes of breakwater failure. This paper outlines: 1) Developed Geology and the ground model, 2) The techniques used for the installation of bamboo piles, 3) Details of the analyses including modes and mechanism of failure and 4) Design changes incorporated to reduce the risk of failure.

Keywords : bamboo piles, ground improvement, reclamation, breakwater failure

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