Optimizing HDPE Geocell Reinforcement Heights for Shallow Foundation Beds: A Comprehensive Assessment of Environmental Impacts, Ultimate Bearing Capacity, and Settlement

Julianne Grace C. Cajulao
Mapúa University, Manila, Philippines

Denise Bianca V. Cruz
Mapúa University, Manila, Philippines

Maria Rafaela L. Gangoso
Mapúa University, Manila, Philippines

Edgardo S. Cruz
Mapúa University, Manila, Philippines

Abstract

Silty sand soil is characterized by low bearing capacity and high susceptibility to differential settlement. To mitigate these limitations, this study aims to optimize the design parameters for geocell-reinforced shallow foundations, focused on the influence of high-density polyethylene (HDPE) geocell height on ultimate bearing capacity (UBC) and settlement behavior. Finite element analysis (FEA) was performed using PLAXIS 3D, using soil properties obtained from three geotechnical reports and HDPE geocell specifications from Hengfeng Plastic Co., Ltd. Linear regression was applied to determine the relationship of geocell height with UBC and settlement. The environmental impacts of a conventional shallow foundation and a geocell-reinforced foundation with a 100 mm geocell height were compared through life cycle assessment (LCA) using openLCA, with results normalized and weighted. FEA identified the 100 mm HDPE geocell height as optimal for balancing increased UBC and reduced settlement, while LCA revealed significantly higher human toxicity, abiotic resource depletion, and marine aquatic ecotoxicity compared to the conventional shallow foundation.

Keywords

HDPE geocell, life cycle assessment, shallow foundations, silty sand, bearing capacity, settlement, finite element method.