TU Clausthal
Clausthal University of Technology

Summary

Geosynthetics are used in many different applications, e.g. in reinforced walls, for erosion control or for the stabilization of soils with low bearing capacity. In unpaved and paved road constructions over soft soils with low bearing capacity, geogrids and nonwoven geotextiles are often used to reduce the settlements and to increase the bearing capacity. Geocells can be used as an alternative for the stabilization of road constructions over soft soils. Geocells are honeycomb interconnected cells that completely encase the soil and provide an all-around confinement, thus preventing the lateral spreading of the infill material. As a result the stiffness and the load-deformation behavior of the soil are increased and the vertical loads are distributed over a much larger area of the subgrade soil. At the moment the acceptance of geocells for base reinforcement of roads is limited due to the lack of design methods which is a result of the limited understanding of the load transfer mechanism within the geocell systems.

This work describes the evaluation of an experimental test program to investigate the load-deformation behavior of geocell stabilized soils and to investigate the load transfer mechanism within a geocell system. For the investigation of the load-deformation behavior static and cyclic large scale model tests were carried out. A radial load test device was constructed to evaluate the load transfer mechanism within a geocells system. On basis of the test results an analytical model has been developed to describe the interaction of different load transfer mechanism with the geocell structure. Due to an extension the model could be transferred into an universal design method for the calculation of the load bearing capacity and the settlement of a geocell stabilized soil.

In more than 58 static and cyclic large scale model tests an influence of the geocell geometry (diameter, height, mattress width) on the load-deformation behavior and the vertical stress distribution on the subgrade was identified. The decrease of the geocell diameter and the increase of the cell height lead to an increase of the bearing capacity of sand. The vertical stresses on the subgrade were also reduced. With increase of the layer thickness above the soft soil a decrease of the geocell performance was observed.

The results of the model tests could be verified by in-situ test results. During the construction of two different in-situ test fields a vertical stress reduction on the subgrade material was measured due to the use of geocells. Falling Weight Deflectometer measurements showed, that the stiffness of the geocell stabilized road sections has been increased and the deflections has been reduced due to the use of geocells.

In more than 200 static and cyclic radial load tests the load transfer mechanism within the geocell system was investigated. The results show that the load transfer mechanism of a geocell system consists of two main parameters: Hoop stresses within the geocell walls and passive earth resistance due to the adjacent geocells. In the test the stiffness of the material, the opening of the junction points and the number of adjacent cells are identified as core parameters.

Based on the experimental results, an analytical model of the interaction of different load transfer mechanism is developed. Due to additional tests the analytical model was advanced to a common usable design model. The design model can be used for the calculation of settlement and bearing capacity of geocell stabilized soil layer. The design concept is explained on an example.