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Summary

When used in reinforced structures, bridging of voids or abutments geosynthetics are exposed to static and cylic loadings from traffic, machines and construction work. For the proof of internal stability in these structures detailed knowledge of the interaction behaviour between the geosynthetic and the surrounding soil in the anchorage area is required. No sufficient experience of the behaviour under cyclic loadings is available at the moment. Initially an extensive experimental framework and a standardised cyclic testing procedure have been evaluated to investigate the behaviour of the materials. Therefore, the development and construction of a new, multifunctional testing device and measuring system has been carried out to perform large scale static and cyclic pull-out tests.

In more than 55 static index- and modeltests the grain size distribution, density of the soil, embedment length of the geosynthetic and the vertical surcharge have been identified as core parameters for the maximum pull-out force. However, for the development of displacements in the geosynthetic specimen, embedment length and surcharge are relevant. Knowledge of the force-elongation-relation of the geosynthetic and the measured elongations in the embedded specimen allows an estimation of the load transference from the geosynthetic in the soil and the development of forces in the specimen. “Passive earth resistance” and “interlock” in front of the transverse bars are the prevailing mechanisms of load transference with grid structures.

In more than 80 cyclic model tests the maximum cyclic load, the amplitude of the cyclic loading and the number of cycles are identified as core parameters. An increase of displacements of the specimen is concomitant with an increasing number of applied cycles. Nevertheless, a hazardous sudden failure was not detected with the grid structures due to their load transference mechanisms. Load transference of cyclic model tests seems to be more consistant over the embedment length than in the static reference tests. This can be explained by a distinctive load transfer in the rear part of the specimen. An improvement of the compound behaviour after application of the cycles due to a “compaction of the soil” and a “cyclic interlock” is monitored.

The database is used for the development of a universal methodology to calculate displacements of the structures depending on the amplitude of the cycles and the maximum cyclic loading. Thereby slight differences are monitored with different geosynthetics and soils. The effects of the core parameters on the displacement behaviour are illustrated by displacement grids. A failure criterion is defined to extract a prediction of the limit state behaviour of the structure from the displacement-based data. By applying this methodology, a prediction of a stable behaviour or a failure of the specimen is possible.

Based on the presented experimental data, a universal concept for the calculation of the anchorage area of cyclic loaded structures is developed. A nomogram and an analytical method are given with which the optimal cyclic anchorage length can be determined for every layer of a reinforced structure. An implementation of this approach into a given concept is possible and is applied to a sample.