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PRESTRESSED GEOSYNTHETIC REINFORCED SOIL BY COMPACTION

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SUMMARY

Prestressed reinforced concrete is a state of the art construction method. In this poster prestressed geotextile reinforced soil is presented. It is already known that the building up process of a geogrid reinforced embankment is an important factor of the building's long time performance. Deformations in the soil need to occur to activate tensile forces in the geogrid by soil-grid interaction. The more deformation in the soil and the better interaction between soil and geogrid the higher are the forces in the reinforcement. To avoid high deformations after the building up process of the embankment it is important to activate the tensile forces in the geogrid during the compaction respectively construction process. Prestressing the geogrid reinforcement with the help and as a result of compaction is therefore researched and demonstrated by using a mesoscopic discrete element method (DEM) analysis with the Particle Flow Code in three dimensions. Qualitatively prestressed reinforcing as a result of compaction is numerically analyzed and validated by a small scale laboratory test. In this poster the method of prestressing the geogrid by compaction is presented and the performance of a specific compaction advice is qualitatively confirmed.

REFERENCES

- CUNDALL, P.A, STRACK, O.D.L., 1979. A discrete numerical model for granular assemblies. Geotechnique 29, No 1, 47-65.
- DETERT, O., WEHRLI, E., CEJKA, A., 2004. Innovative applications of geogrids as tie-back anchors for vertical walls. EuroGeo4, 260.
- DGGT AK 5.2, EBGEO, 2009. Berechnung und Dimensionierung von Erdkörpern mit Bewehrungseinlagen aus Geokunststoffen (Entwurf 2009). Deutsche Gesellschaft für Geotechnik e.V., Essen.
- ITASCA CONSULTING GROUP, INC, 2005. PFC3D Particle flow code in 3 dimensions – command reference. Itasca Consulting Group, Inc., Minneapolis.
- KONIECKY, H. 2004. Numerical modelling of soil-geosynthetic systems. Proceedings of the ECI International Conference on the use of geosynthetics in soil reinforcement and dynamics , Dresden.
- ZHANG, J., YASUFUKU, N., OCHIAI, H., 2007. Discrete element modelling of geogrid pull out test. Proceedings of the 4th Asian Regional Conference on Geosynthetics in Shanghai, 11-14, Shanghai.

INTRODUCTION

Since more than forty years reinforced soil is an important engineering tool for geotechnical problems. Since nearly twenty years geosynthetics as reinforcement are used and these materials are further developed. The idea for taking a step forward and prestressing the reinforcement, generally geogrids, is based on the theory of prestressed concrete. The use for pre-stressing the reinforcement is on the one hand defining a special stress level and on the other hand reducing displacements. Defined stress-conditions can be constituted by constructively prestressing the reinforcement. Therefore several options are possible. For example tensioning the geogrid with the shovel of an excavator leads to a defined stress level in the geogrid (Detert et al 2004). The current idea at the Institute of Soil Mechanics and Foundation Engineering at Graz University of Technology for pre-stressing the geotextile reinforcement is compacting the soil-layers filled on the geogrid in a specific way.

COMPACTION ADVICE

A defined prestressing in the geogrid because of compacting the overfilled granular soil layer can be achieved by using the spreading stresses occurring between soil and geogrid. During compaction loads affect on the reinforced soil. These loads lead to deformation of the loosely dumped soil and thereby to a change of the vertical and horizontal stresses. At the bottom of a soil-layer where the geogrid is applied, spreading forces reach their maximum and because of interaction between soil and reinforcement a tensile force in the geogrid occurs.

NUMERICAL MODEL

Before dealing with tensile forces in the geogrid due to prestressing by compaction, the understanding for the interactive behavior between the reinforcing geogrid and the surrounding soil has to be approved. Therefore a numerical model is applied to show the soil-geogrid interaction. For this mesoscopic scale problem a three dimensional discrete element analysis (DEM) with the Particle Flow Code (Itasca Consulting Group 2005) is performed. The model is generated by spherical discrete elements so called particles which move independently of one another and interact at contacts of the particles. The system's mechanical behavior is described by the movement of each particle. Newton's law of motion provides the fundamental relationship between particle motion and forces causing motion. The numerical model simulates a test where a geogrid is laid on a stiff plane layer and covered with a layer of soil. To demonstrate the system's behavior a biaxial geogrid 2.0 m * 1.0 m is generated with discrete elements. Figure 2 shows the discrete generated model with the three dimensional Particle Flow Code.

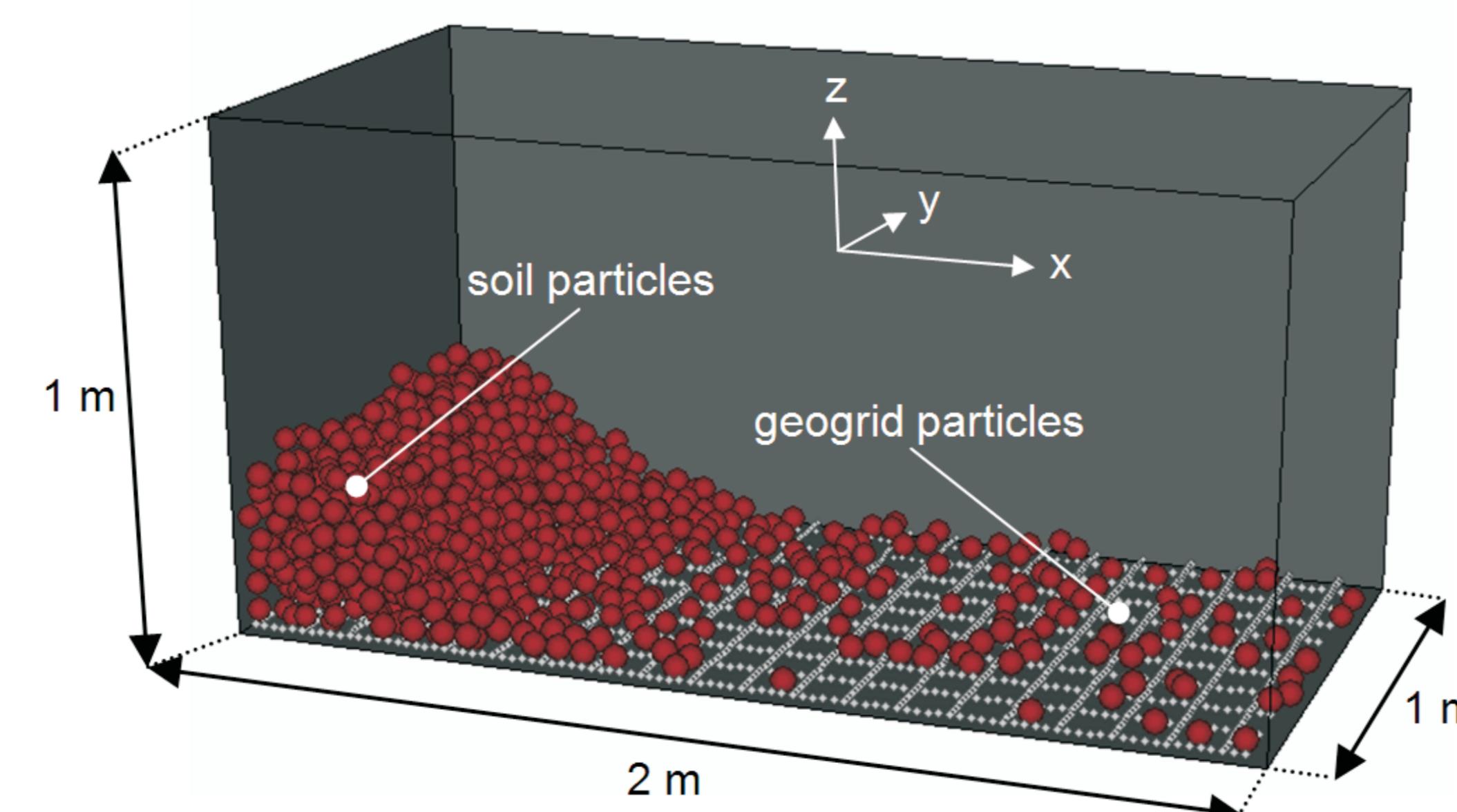


Figure 1: Generated model with the Particle Flow Code

By modeling the sequence of compaction a detailed insight in the interactive behavior of the geogrid and the overfilled soil can be gained. This general understanding helps to develop the concept of prestressing the reinforcement as a result of compaction. The results of the DEM

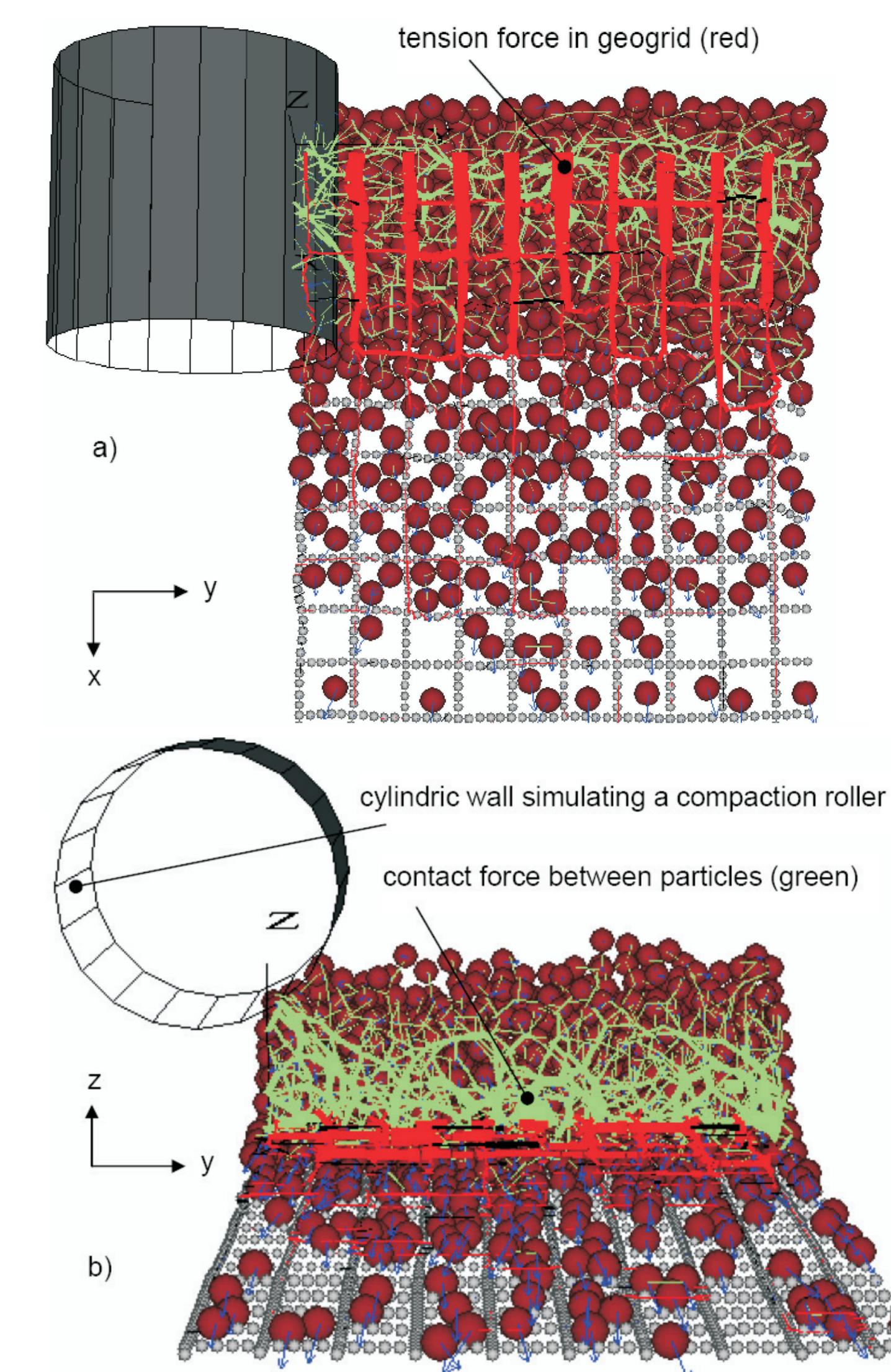


Figure 2: Discrete model of granular soil, geogrid and compaction roller. a) Topview b) Frontview

With the help of the described simulation parameter studies referring to the grain size and mesh distance respectively surface roughnesses of the geogrid can be performed to quantitatively describe these effects.

SMALL SCALE LAB TEST

In order to qualitatively validate the system of prestressed geogrid reinforced soil a small scale lab test was performed. Because of the

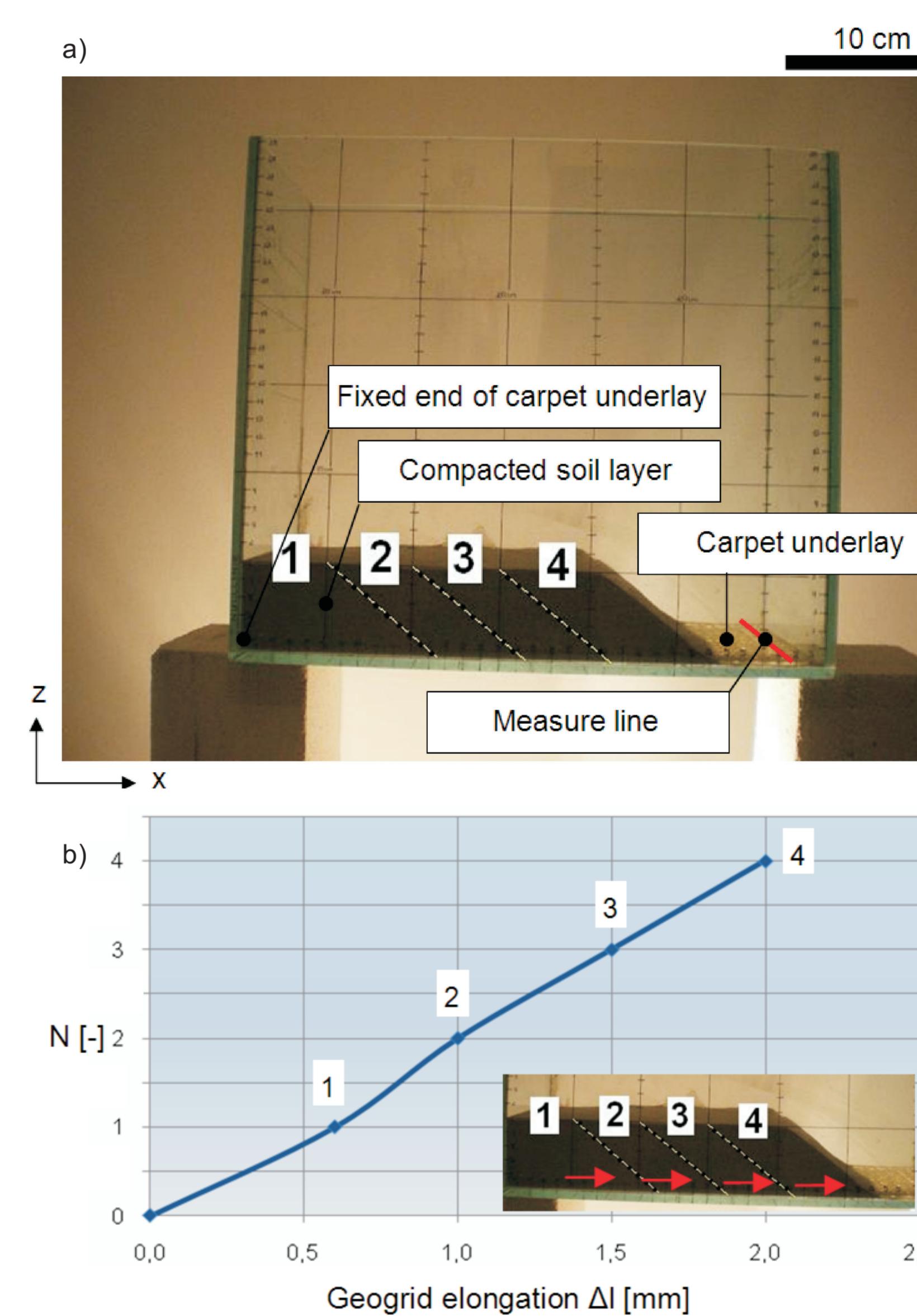


Figure 3: Small Scale Lab Test to measure the grid's elongation by prestressing by compaction. a) Glasbox b) Compaction - elongation curve

CONCLUSION AND OUTLOOK

In this poster a short overview on prestressed reinforced soil was given. Prestressing the geogrid as a result of compaction was presented. In order to quantitatively confirm the compaction advice more calibration work for the numerical simulation has to be done. Therefore a large scale lab test will be performed to show the positive effects of prestressing the geogrid during compaction to minimize deformation after the building process.