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目　录

Effects of a very low pH solution on the properties of an HDPE geomembrane

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Abstract: The effects of a very low pH solution (pH=0.5) on a high-density polyethylene (HDPE) geomembrane (GMB) are evaluated using accelerated ageing tests. The GMB specimenswere incubated at 65 ℃, 75 ℃, and 85 ℃ for up to 19 months. They were periodically removed from the immersion media and tested for retained chemical, mechanical and physical properties. The antioxidant depletion rates obtained from standard oxidative induction time (Std-OIT) tests were consistently lower than that obtained from high-pressure oxidative induction time (HP-OIT) tests at the three temperatures. This difference led to two substantially different estimates of antioxidant depletion time. The relationship between Std-OIT and HP-OIT was non-linear. It indicates the importance of using both methods to assess antioxidant depletion time of GMBs. Crystallinity, melt flow index (MFI) and tensile test results show that physical ageing has occurred, but no significant changes in physical properties due to oxidative degradation were observed after 19 months' immersion.

Keywords: Geosynthetics, HDPE, geomembranes, low pH solutions, antioxidant depletion

Testing and analytical modeling of two-dimensional geotextile tube dewatering process

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Abstract: Geotextile tubes are used to dewater slurries, sediments, and wastes. With their extensive use for dewatering, the desire to maximize both dewatering rate and sediment retention has led to the use of chemical accelerants, which have become a standard practice in geotextile tube dewatering projects. Avariety of test methods are currently used to evaluate geotextile tube performance, ranging from small-scale Falling Head Tests (FHTs), medium-scale Hanging Bag Tests (HBTs), and Geotextile-tube Demonstration Tests (GDTs), to full-scale pilot tests. However, few studies have compared the results from different dewatering tests and fewer have developed proper correlations between test methods. In this study, a recently developed pressurized two-dimensional dewatering test (P2DT) is used to analyze the dewatering process in geotextile tubes in both the radial and axial directions. In this study, P2DT and GDT tests were performed on Tully slurry at different solids concentrations conditioned with chemical accelerants and under different pressures. The P2DT results, along with analytical modeling, are then used to predict the dewatering behavior of GDTs based on P2DT, where the predictions were within 8%. Based on the results, a framework for predicting the dewatering behavior of full-scale tests using an analytical model generated from P2DT is presented.

Keywords: Geosynthetics, Geotextile tube, 2D test, Percent solids, Modeling, GDT, Dewatering

Optimal design of piled embankments with basal reinforcement

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Abstract: The paper presents an optimal design for piled embankments with basal reinforcement based on multi-parametric mixed-integer non-linear programming (MINLP) optimization. For this purpose, an optimization model, PILEM, was developed. The model comprises an accurate objective function of the structure's production cost subjected to design, resistance, stiffness and settlement constraints. The intention of the model was to satisfy the requirements of the ultimate and serviceability limit states, according to the required specifications and recommendations. The optimal design of piled embankments with basal reinforcement was investigated to determine the design parameters that have a significant impact on a structure's cost. A series of MINLP optimizations were thus executed over a wide range of various parameters: different thicknesses of soft stratum, different geosynthetic strengths, alternative discrete cross-sections and different bearing capacities of deeper stable soil stratum. The results show that the proper selection of geosynthetics leads to a significant decrease in costs. As the model was developed for general use, the optimization of piled embankments with basal reinforcement can be performed for different economic conditions and different design parameters. This study can help engineers choose piled embankments and geosynthetic reinforcements that are economical in design.

Keywords: Geosynthetics, Computational modeling, Numerical analysis, Piled embankment, Structural optimization

Deterministic and random FEM analysis of full-scale unreinforced and reinforced embankments

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Abstract: This paper presents the results of numerical simulations of one physical full-scale unreinforced embankment and two reinforced embankments taken to failure using a strip footing. The embankments were 3.4 m in height and were constructed with the same slope using the same sand backfill. One reinforced embankment was constructed with a relatively weak and extensible geogrid material and the other with a relatively stronger and stiffer geogrid product. Deterministic finite element method (FEM) and random finite element method (RFEM) analyses were carried out and the results compared to observed performance. Analyses were performed assuming vertical spatial variability in soil strength at a scale of fluctuation matching the compaction lift thickness of the physical tests and treating the soil as a random (homogeneous) material. Both deterministic and probabilistic analyses showed good agreement with the measured bearing capacity of the footing in each full-scale test. However, the assumption of vertically anisotropic spatial variability in soil strength was shown to achieve a better match with the observed failure mechanism in each of the embankments.

Keywords: Geosynthetics, Finite element method, Random finite element method, Random field, Numerical simulation, Bearing capacity, Embankment, Reinforcement

Numerical study of earth pressure reduction on rigid walls using EPS geofoam inclusions

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Abstract: This paper presents a numerical study performed to investigate the compressible inclusion function of Expanded Polystyrene (EPS) geofoam panels placed behind a non-yielding rigid wall. EPS geofoam panels placed behind a non-yielding wall can reduce lateral earth pressure acting on the wall by accommodating the lateral movement of the retained soil. Laboratory-scale physical testing was performed to evaluate various combinations of properties and dimensions of an EPS geofoam panel. A numerical model was developed to simulate the laboratory-scale tests. Model outputs were compared against test results to assess the reasonableness of the numerical predictions. A parametric study was performed using the numerical model to evaluate the effects of EPS geofoam panel material type and thickness on the non-yielding wall performance. The results of the parametric study quantify the magnitude of lateral earth pressure when the EPS geofoam panel is selected. Also, a systematic design approach for EPS geofoam panels as compressible inclusions against non-yielding walls is proposed based on the results of this parametric study.

Keywords: Geosynthetics, lateral earth pressure, Non-yielding rigid wall behavior, Compacted frictional backfill soil, Compressible inclusion, Expanded polystyrene (EPS) geofoam, Numerical study

Optimal reliability based design of V-shaped anchor trenches for MSW landfills

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Abstract: Geomembrane liners that are installed in anchor trenches may experience pullout failure when the applied tensile stress exceeds the allowable strength of the liner. Deterministic analysis approaches do not consider the variability of the unit weight and friction angle of the soil, interface friction between the geomembrane and the cover soil, and tensile strength of the geomembrane. An analytical expression based on the Euler-Eytelwein equation is derived for the mobilized tension in the anchor. This paper proposes a new procedure for the target reliability-based design optimization (TRBDO) of V-shaped anchor trenches. The effect of the bend resistance on the GMB tensile force and reliability index is discussed. This approach is used to determine an optimal allowable geomembrane tensile force required to avoid pullout failure such that the prescribed reliability indices are attained in the presence of parameter variability. The optimization methodology is useful to develop modifications for conventional analytical models in practice. Thus, the proposed procedure combines modern concepts of reliability analysis, anchor trench design, and nonlinear constrained optimization to develop a rational and practical procedure for the optimal design of V-shaped anchor trenches.

Keywords: Geosynthetics, Reliability, V-shaped anchor trench, Optimization, Pullout failure, Geomembrane

Field and laboratory time-dependent behaviors of geotextiles in reinforced soil walls

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Abstract: Laboratory and field investigation of time-dependent behavior of geotextiles reinforcing a fine-grained soil are evaluated herein. The field assessment consisted of analyses of two instrumented sections of a geotextile reinforced soil wall with identical layouts, including one section with a woven and another with a nonwoven geotextile. In addition, in-soil and in-isolation laboratory creep tests were conducted using the same geosynthetics and soil used in the Geosynthetic-Reinforced Soil (GRS) wall sections to better assess time-dependent behaviors in the field. Construction and time-dependent behavior of the full-scale GRS wall proved to be satisfactory over the 4 years of monitoring of both woven and nonwoven geotextile structures. Soil confinement, due to vertical earth pressure on the reinforcement, was found to greatly affect the deformability of the nonwoven geotextile and to have a minor effect on the woven geotextile. Time-dependent strain rates were higher when the failure stress state of the soil was reached. Under lower vertical stresses, the time-dependent behavior of both geosynthetics was similar. Time-dependent behavior was underestimated from in-soil laboratory creep tests and better estimated using in-isolation laboratory tests. However, the GRS wall data did not account for installation damage and wetting-drying processes, which were found to influence time dependent strain predictions.

Keywords: Geosynthetics, Geotextile, Time-dependent, Creep strains, Tensile loads, Reinforced soil wall

Evaluation of predictions of nonwoven geotextile pore size distribution under confinement

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Abstract: Geotextiles are commonly used as filters in geotechnical and geoenvironmental works. For a proper design of a geotextile, filter pore dimensions and gradation are necessary and the equivalent diameter of these pores depends on the confining vertical stress acting on the geotextile layer. This paper investigates the dependency of the geotextile pore size distribution curve on confinement, and addresses the accuracy and calibration of two well-known methods for the estimate of pore dimensions. Five nonwoven geotextiles, made of polyester, were tested in Bubble Point test equipment under unconfined and confined (vertical stresses up to 1000 kPa) conditions. The study aimed mainly to calibrate and expand the applicability of two well-known methods to estimate geotextile pore size distribution based on results from Bubble Point tests. Several hypotheses were addressed to back-analyse parameters relevant for the accuracy of such methods. The results obtained showed that these solutions predicted satisfactorily the pore size distribution curves of the products tested when appropriate values of relevant parameters were employed.

Keywords: Geosynthetics, Nonwoven geotextiles, Filters, Pore size distribution curves, Bubble point test, Confinement

Large-scale tests to assess the efficiency of a geosynthetic reinforcement over a cavity

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Abstract: This report presents a new large-scale test apparatus (LSTA) developed to assess the efficiency of a geosynthetic reinforcement for the limitation of deformations of a geosynthetic lining system (GLS) over a 0.5 m wide cavity. Two experiments were conducted. The first one involved a geosynthetic clay liner, a nonwoven needle-punched geotextile and a high-density polyethylene geomembrane. For the second experiment, a 50 kN/m polyvinyl alcohol geogrid was imbedded within the sand layer below the geosynthetic clay liner to provide reinforcement above the cavity. An overburden pressure varying from 10 to 100 kPa was applied to the top of the GLS. Strain gauges were used to measure the strain within the geogrid and the geomembrane. The results proved that the 50 kN/m geogrid reinforcement beneath the geomembrane reduced the maximum strain within the geomembrane, compared to the case where the geomembrane was unreinforced, by 25% on average. The results showed that the overall strain within the geomembrane was 31% to 42% less than that of the geogrid above the cavity. Finally, the results showed that the spatial distribution of the strain within the geomembrane and that of the geogrid differed because of a conical shape of the collapsed zone.

Keywords: Geosynthetics, Reinforcement, Cavity, Strain gauge, Total pressure cell, Large-scale test